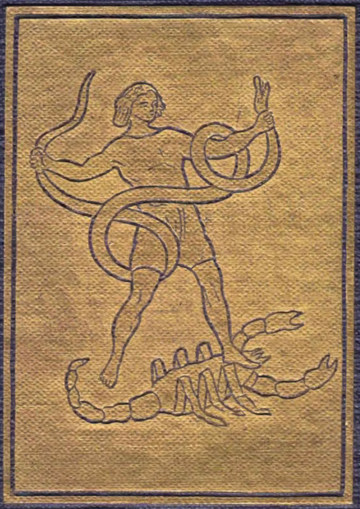
Norton's Star Atlas

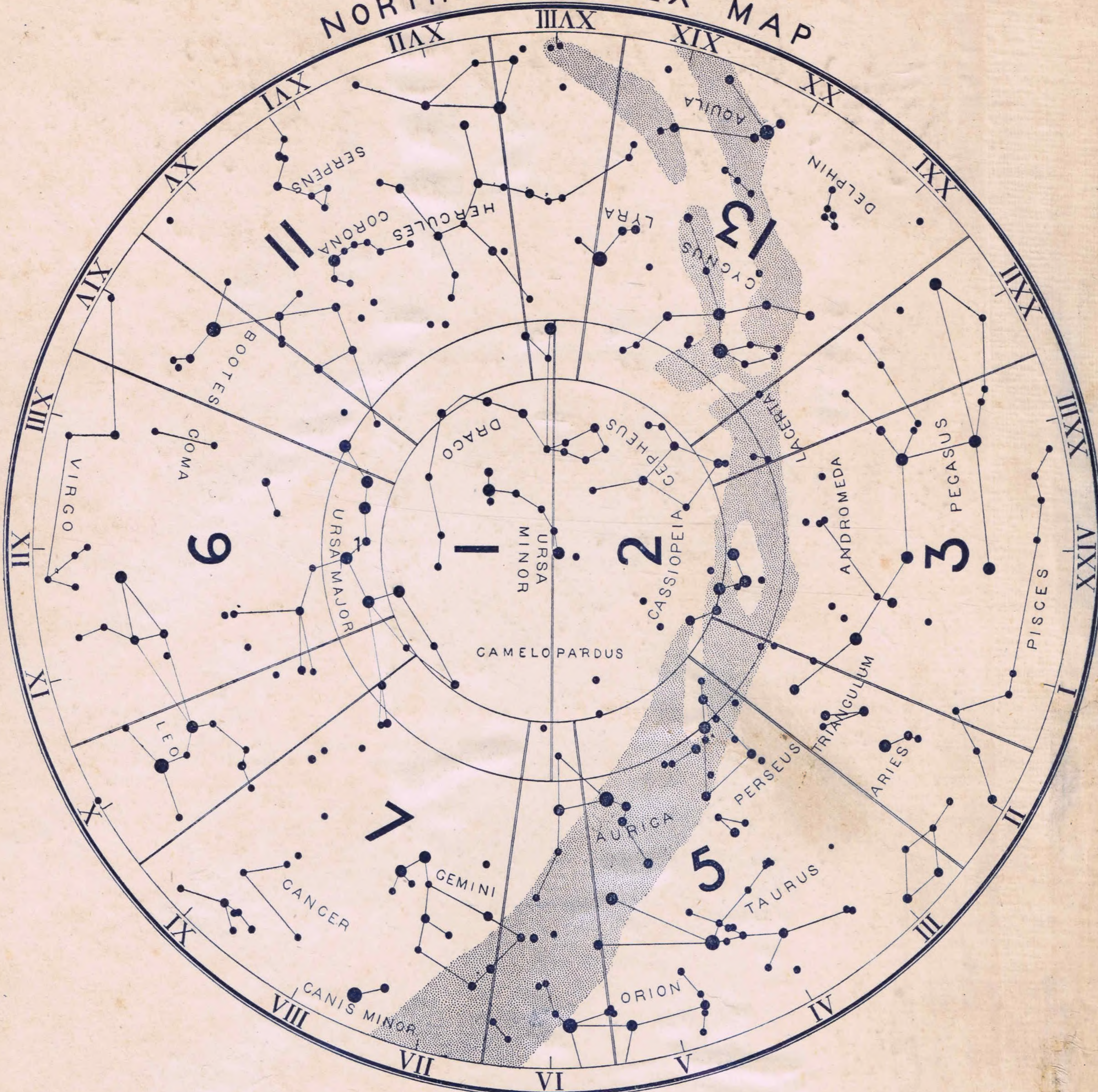
and Telescopic Handbook

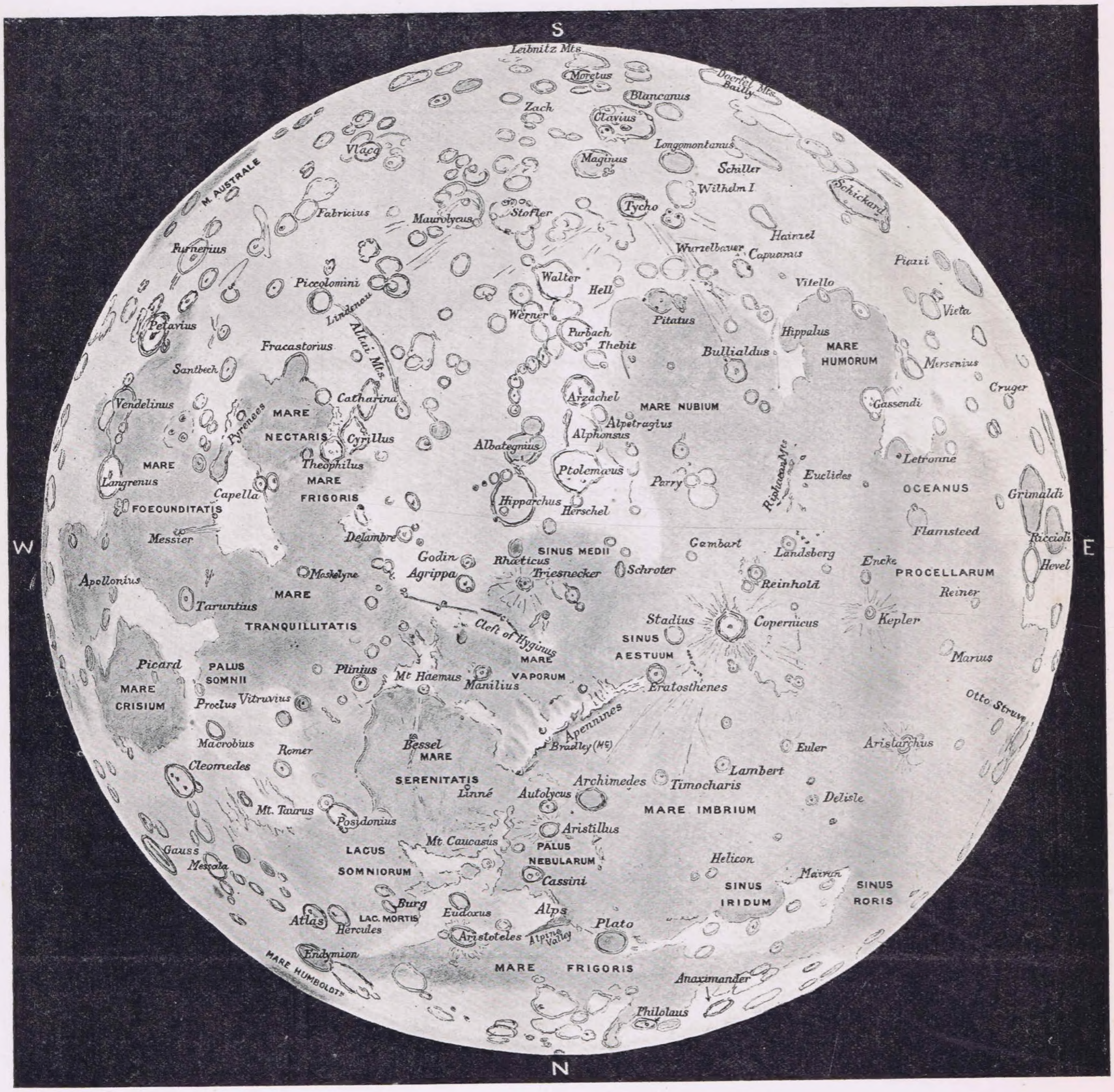


7000 STARS, CLUSTERS, NEBULÆ, &c.

FOR EPOCH 1920.

NORTHERN INDEX MAP





SKETCH MAP OF THE MOON
(as seen in an inverting Telescope).

A STAR ATLAS

AND TELESCOPIC HANDBOOK

(EPOCH 1920)

FOR STUDENTS AND AMATEURS

Covering the whole Star Sphere, and showing over 7000 Stars, Nebulæ, and Clusters; with Short Descriptive Lists of Objects suitable for Small Telescopes; Notes on Planets, Star Nomenclature, &c.

BY

ARTHUR P. NORTON, B.A.

London:

GALL AND INGLIS, 31 HENRIETTA STREET, STRAND, W.C.;

AND EDINBURGH.

1910

PREFATORY NOTE.

THIS Atlas is primarily intended for the use of those amateur telescopists whose instruments are mounted either on alt-azimuth stands or as equatorials without graduated circles.

In order to make proper use of a set of star maps, however, it is necessary to be able to recognise at least the more important constellations and their relative positions. It is also necessary to have a proper conception of their apparent daily motions. There is a very useful little book, "An Easy Guide to the Constellations," by the Rev. James Gall (Gall & Inglis), which could be used by the beginner with great advantage as an introduction to the present work.

Short popular explanations of various astronomical terms met with in almanacs and current astronomical literature are given for the benefit of the beginner, and notes on the moon and planets, also selected lists of interesting objects, for the convenience of the occasional observer: but the maps are rather intended to be used as a companion to Webb's invaluable "Celestial Objects for Common Telescopes," and Smyth's admirable "Cycle of Celestial Objects." Practically all the objects contained in the latest editions of these two works, down to and including stars of the seventh magnitude, are shown in the following maps. Several fainter objects of particular interest are added.

The "Uranométrie Générale" of Houzeau, and certain of the catalogues of the Greenwich and Cape Observatories, have also been used in the construction of these maps, so that probably few stars visible to the naked eye have been omitted. Houzeau's work contains the places of 5719 naked-eye stars. In the nomenclature adopted by him, Houzeau has not been followed, nor always in his estimates of star magnitudes. The Revised Harvard Photometry has also been consulted.

Altogether the charts indicate the positions of upwards of 6,500 stars and 600 nebulæ, for the epoch 1920.

Owing to the plan and arrangement of the maps, a view of about one-fifth of the entire heavens can be seen on one folio. For this reason, and also on account of the large overlap of the maps, no constellation is inconveniently broken up. The distortion is slight, considering the large area of the heavens represented on each chart.

It has been thought inadvisable to insert letters near the stars in order to denote their duplicity, &c. (except "V" for variable and "R" for red), as such particulars can be more satisfactorily obtained from the lists which must necessarily be used in conjunction with the Atlas : all lettering is made faint so as not to confuse the star groups.

The lines marking the hours of Right Ascension and every tenth degree of Declination are shown in the maps: intermediate distances may be estimated by means of the marginal divisions which mark intervals of five minutes in Right Ascension, and degrees of Declination.

The Author is indebted to the Publishers for several suggestions as to the form and scope of the letterpress, and for the draft of pages 5 to 13, prepared by the Editor of the recently revised edition of the "Easy Guide to the Constellations," to which reference has already been made.

Very great pains have been taken to make the maps correct; but, where so many objects have been charted, one cannot feel confident that no mistake has been made. The writer will be grateful to anyone who, having detected an error, will kindly communicate with him.

ARTHUR P. NORTON.

BRANDON PARVA,
WYMONDHAM, NORFOLK.
1910.

INDEX OF CONTENTS.

MAGNITUDES AND RELATIVE BRIGHTNESS OF PLANETS, STARS, &c.

Compared with a standard 1st magnitude star. The star magnitudes only are from the Revised Harvard Photometry.

Name of Star.	H.R. Mag.	Approx. Relative Brightness.	Name of Star.	H.R. Mag.	Approx. Relative Brightness.	Name of Star.	H.R. Mag.	Approx. Relative Brightness.	Name of Star.	H.R. Mag.	Approx. Relative Brightness.
Sun ...	−26·6	109,650 millions	Achernar ...	0·60	1·45	γ Crucis ...	1·60	0·58	ε Sagittarii...	1·95	0·42
Moon ...	−12·2	190,550	β Centauri ...	0·86	1·14	ε Canis Maj.	1·63	0·56	α Ursæ Maj.	1·95	0·42
Venus	−4·28	129·4	Altair	0·89	1·11	ε Ursæ Maj.	1·68	0·53	δ Canis Maj.	1·98	0·41
Jupiter* ...	−2·52	25·59	Betelgeuse ...	0·92	1·08	γ Orionis ...	1·70	0·52	β Canis Maj.	1·99	0·40
Mars*	−2·25	19·95	Magnitude	1·00	1·00	α^2 Centauri ...	1·70	0·52	Magnitude	2·00	0·40
Sirius	−1·58	10·77	Aldebaran ...	1·06	0·95	λ Scorpionis	1·71	0·52	Polaris	2·12	0·36
Saturn* ...	−0·93	5·92	Spica	1·21	0·82	ε Carinæ ...	1·74	0·51	Magnitude	2·50	0·25
Canopus ...	−0·86	5·55	Pollux	1·21	0·82	ε Orionis ...	1·75	0·50	,, ...	3·00	0·16
Magnitude	0·00	2·51	Antares	1·22	0·82	β Tauri	1·78	0·49	,, ...	3·50	0·10
Vega	0·14	2·21	Fomalhaut ...	1·29	0·77	β Carinæ ...	1·80	0·48	,, ...	4·00	0.06
Capella ...	0·21	2·07	Arided	1·33	0·74	α Triang. Aust.	1·88	0·44	,, ...	4·50	0·04
Arcturus ...	0·24	2·01	Regulus... ...	1·34	0·73	α Persei ...	1·90	0·44	,, ...	5·00	0·03
α^1 Centauri	0·33	1·85	β Crucis ...	1·50	0·63	η Ursæ Maj.	1·91	0·43	,, ...	5·50	0·02
Rigel	0·34	1·84	α^1 Crucis ...	1·58	0·59	ζ Orionis ...	1·91	0·43	,, ...	6·00	0·01
Procyon ...	0·48	1·61	Castor	1·58	0·59	γ Geminorum	1·93	0·42	,, ...	6·50	0·006

* Mean opposition magnitudes.

DATE WHEN THE CENTRAL MERIDIAN OF EACH MAP IS ON THE MERIDIAN.

APPROX. DATE WHEN ON THE MERIDIAN—*i.e.* on the line due north and south.

No. of Map.	*Central Meridian*	*At 8 p.m.*	*At 10 p.m.*	*At Midnight.*	*At 2 a.m.*	*At 4 a.m.*
Maps 3 and 4	XXIV hrs.	Nov. 21	Oct. 22	Sept. 21	Aug. 22	July 22
,, 5 ,, 6	IV ,,	Jan. 21	Dec. 21	Nov. 21	Oct. 22	Sept. 21
,, 7 ,, 8	VIII ,,	March 23	Feb. 20	Jan. 21	Dec. 21	Nov. 21
,, 9 ,, 10	XII ,,	May 22	April 22	March 22	Feb. 20	Jan. 21
,, 11 ,, 12	XVI ,,	July 22	June 22	May 22	April 22	March 22
,, 13 ,, 14	XX ,,	Sept. 21	Aug. 22	July 22	June 22	May 22

Examples.—(1) When will the constellation Taurus be south at 10 p.m.? From the Index of Constellations we find that Taurus is in Map 5. On referring to the above table, opposite Map 5, in the column headed 10 p.m., we learn that the date will be December 21.

(2) What constellations are in the south at 8 p.m. on March 23? We find the date, March 23, in the column headed 8 p.m., and see that Maps 7 & 8 are then south, containing Gemini, Cancer, Hydra, &c.

THE GREEK ALPHABET.

Letter.	Name.	Letter.	Name.	Letter.	Name.	Letter.	Name.	Letter.	Name.	Letter.	Name.
α	Alpha	ε	Epsilon	ι	Iota	ν	Nu	ρ	Rho	φ	Phi
β	Beta	ζ	Zeta	κ	Kappa	ξ	Xi	σ	Sigma	χ	Chi
γ	Gamma	η	Eta	λ	Lambda	ο	Omicron	τ	Tau	ψ	Psi
δ	Delta	θ	Theta	μ	Mu	π	Pi	υ	Upsilon	ω	Omega

THE HOUR OF RIGHT ASCENSION ON THE MERIDIAN AT 9 P.M.

Or Sidereal Time at 9 p.m. For each hour earlier, subtract one hour of R.A.; for each hour later, add one hour of R.A.

Date.	Right Ascension at 9 p.m.	Date.	Right Ascension at 9 p.m.	Date.	Right Ascension at 9 p.m.	Date.	Right Ascension at 9 p.m.	Date.	Right Ascension at 9 p.m.	Date.	Right Ascension at 9 p.m.
	h. m.		h. m.		h. m.		h. m.		h. m.		h. m.
Jan. 1	III 40	Mar. 2	VII 40	May 2	XI 40	July 2	XV 40	Sept. 1	XIX 40	Nov. 1	XXIII 40
,, 5	IV 0	,, 7	VIII 0	,, 7	XII 0	,, 7	XVI 0	,, 6	XX 0	,, 6	XXIV 0
,, 10	,, 20	,, 12	,, 20	,, 12	,, 20	,, 12	,, 20	,, 11	,, 20	,, 11	,, 20
,, 13	,, 30	,, 15	,, 30	,, 15	,, 30	,, 15	,, 30	,, 14	,, 30	,, 13	,, 30
,, 16	,, 40	,, 17	,, 40	,, 17	,, 40	,, 17	,, 40	,, 16	,, 40	,, 16	,, 40
,, 21	V 0	,, 23	IX 0	,, 22	XIII 0	,, 22	XVII 0	,, 21	XXI 0	,, 21	I h. 0
,, 26	,, 20	,, 28	,, 20	,, 27	,, 20	,, 27	,, 20	,, 26	,, 20	,, 26	,, 20
,, 28	,, 30	,, 30	,, 30	,, 30	,, 30	,, 30	,, 30	,, 29	,, 30	,, 29	,, 30
,, 31	,, 40	Apr. 2	,, 40	June 2	,, 40	Aug. 1	,, 40	Oct. 1	,, 40	Dec. 1	,, 40
Feb. 5	VI 0	,, 7	X 0	,, 7	XIV 0	,, 6	XVIII 0	,, 6	XXII 0	,, 6	II 0
,, 10	,, 20	,, 12	,, 20	,, 12	,, 20	,, 12	,, 20	,, 12	,, 20	,, 11	,, 20
,, 12	,, 30	,, 14	,, 30	,, 14	,, 30	,, 14	,, 30	,, 14	,, 30	,, 14	,, 30
,, 15	,, 40	,, 17	,, 40	,, 17	,, 40	,, 17	,, 40	,, 17	,, 40	,, 16	,, 40
,, 20	VII 0	,, 22	XI 0	,, 22	XV 0	,, 22	XIX 0	,, 22	XXIII 0	,, 21	III 0
,, 25	,, 20	,, 27	,, 20	,, 27	,, 20	,, 27	,, 20	,, 27	,, 20	,, 27	,, 20
Feb. 28	VII 30	Apr. 30	XI 30	June 29	XV 30	Aug 29	XIX 30	Oct. 29	XXIII 30	Dec. 29	III 30

ABBREVIATIONS.

Greek Letter (to a star). Bayer's designation in his Celestial Atlas, 1603, or that of Lacaille.

Small Roman Letter (to a star). Bayer's designation in his Celestial Atlas, 1603, or that of Lacaille.

Roman Capitals R to Z (to a star). Usually variable stars, except in a few Southern Constellations where there are no Flamsteed numbers. In Cygnus and Virgo these letters, having all been used up, were repeated in the double form RR, RS, RT, &c. In the case of Cygnus, the double combinations of letters from R to Z have now been exhausted, and the series AA, AB to AQ, BB, BC to BQ, and so on, are being assigned, as the variable stars are discovered. Another system in use is to denote the variable by a single letter with an index number added. Thus: RS = S^2 Cephei, ZZ = Z^6 Cygni.

Number only (to a star). The number in Flamsteed's "British Catalogue," published in 1725.

Number only (to a nebula). The number in the New Edition of Sir J. Herschel's General Catalogue of Nebulæ and Clusters.

Number underlined (to a star). The number in Piazzi's Catalogue of 1814.

Numbers, as 39^1, 34^4 (to a nebula). Sir W. Herschel's Nos., and the classes into which he divided the nebulæ.

The small crosses (+) in the maps indicate points of intersection of intermediate 20m. of R.A., and 5° of Dec.

Dec. = Declination	(+ = North Dec.	N.P.D. = North Polar Distance.	R or Ru. (small, to a star) = Red or Ruddy.
Mag. = Magnitude	[− = South Dec.)	R.A. = Right Ascension.	V or Var. (small, to a star) = Variable.

STAR CATALOGUES.

Contraction.	*With number added, = Number in—*
Arg.	... Argelander. (See B.D. below).
B	... Birmingham's Catalogue of Red Stars, 1877.
B.A.C.	... British Association Catalogue of 1845.
B.D.	... Argelander's Bonn "Durchmusterung," 1859-62.*
β ...	... Burnham's Double Star Catalogues.
Br. or Bris.	Sir T. Brisbane's Catalogue of Southern Stars, 1835.
C.G.A.	... Gould's "Catalogo General Argentino," 1886.
Δ	... Dunlop's Catalogues of Double Stars and Nebulæ, 1829.
E-B	... Espin's Edition of Birmingham's Catalogue of Red Stars, 1888.
Gr.	... Groombridge's Catalogue of Circumpolar Stars for 1810. Published in 1838.
H	... Sir W. Herschel's Catalogues of Double Stars, 1782-1822.
Houz.	... Houzeau's Uranométrie Générale, 1878.
h ...	... Sir J. Herschel's Catalogues of (1) Nebulæ, 1833, 1847; and (2) of Double Stars.
H.P.	... Pickering's Harvard Photometry, 1884.
H.R.	... Revised Harvard Photometry, 1908.
Jac.	... Jacob's Catalogue of Double Stars, 1849.
Lac.	... Lacaille's Catalogue of Southern Stars, published by the British Association, 1847.
Ll.	... Lalande's Catalogue, pub. by the B.A., 1837.
M	... Messier's Catalogue of 103 Nebulæ, pub. 1784.
P.	... Piazzi's Star Catalogue, 1803-1814.
Rus.	... Russell's Double Star Measures (Sydney), 1891.
S	... South's Measures of Double Stars, 1826.
Sa.	... Santiago Observations, 1876.
S.M.P.	... Harvard Southern Meridian Photometry, 1895.
St.	... Stone's Cape Catalogue for 1880, or Radcliffe Catalogue for 1890.
U.A.	... Gould's Uranometria Argentina, 1886.
U.O.	... Pritchard's Uranometria Nova Oxoniensis, 1885.
Σ	... F. G. W. Struve's Dorpat Catalogue of Double Stars, 1837.
ΣI	... Do. do. Appendix I.
OΣ	... Otto Struve's Revised Pulkova Catalogue, 1850.
OΣΣ	... Pulkova Catalogue, Part II.

ASTRONOMICAL SYMBOLS.

Conjunction	Opposition	Quadrature	Perihelion	Ascending node	Descending node
☌	☍	□	π	☊	☋

THE SIGNS OF THE ZODIAC.

Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagittarius	Capricornus	Aquarius	Pisces
♈	♉	♊	♋	♌	♍	♎	♏	♐	♑	♒	♓

THE SYMBOLS OF THE PLANETS.

Sun	Mercury	Venus	Moon	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
☉ or ○	☿	♀	☾	⊕ or ♁	♂	♃	♄	♅	♆

* In this case the zone is stated as well as the number. Thus B.D. +13° 2302 means Star No. 2302 in the 13° zone, north, in the B.D.

A STAR ATLAS

FOR SMALL TELESCOPES.

I.—NOTES ON STAR NOMENCLATURE, &c.

The Constellations.—The origin of most of the constellation names is lost in antiquity. COMA BERENICES was added to the old list (though not definitely fixed till the time of Tycho Brahé), early in our Era; but no further addition was made till the seventeenth century, when Bayer, Hevelius, and other astronomers, formed many constellations in the hitherto uncharted regions of the southern heavens, and marked off portions of some of the large or ill-defined ancient constellations into new constellations. Many of these latter, however, were never generally recognised, and have been dropped altogether, or had their names abbreviated into more convenient forms. Since the middle of the eighteenth century, when Lacaille added thirteen additional names in the southern hemisphere, and subdivided the unwieldly ARGO into the more convenient CARINA, MALUS, PUPPIS, and VELA, no new constellations have been recognised. (See list of constellations at end of book).

Star Nomenclature.—The Star Names given in the list on page 19 have for the most part been handed down from classical or early mediæval times, but only a few of them are now in common use, it having been found more convenient to adopt the plan introduced by Bayer in 1603, viz.—the designation of the bright stars in each constellation by the ordinary letters of the Greek Alphabet, α, β, γ, &c. When there were more stars than Greek letters, Roman letters, both ordinary and capital, have also been employed. As the Roman capital letters, however, were not generally used except in the constellations of the far south, the convenient plan has recently been introduced of denoting the principal *variable* stars in each constellation by the Roman capital letters near the end of the alphabet —R, S, T, U, V, &c., thus affording a ready index to their peculiarity. After Z is reached, the letters are duplicated thus—RR, RS, &c.

The fainter stars are most conveniently designated by their numbers in some star catalogue. By universal consent, the numbers of Flamsteed's British Catalogue (published 1725) are adopted for stars to which no Greek letter has been assigned, while for stars not appearing in that catalogue, the numbers of some other catalogue are utilised. For convenience of reference, the more important star catalogues are designated by recognised contractions: thus, "B.A.C. 2130" is at once known by astronomers to denote the star numbered 2130 in the British Association Star Catalogue, published in 1845. A list of some of the best-known catalogues, and their contractions, is given on p. 4. In most star catalogues a number is assigned to each star included in them, whether it has a Greek or other letter, or not. Thus, *Vega* is α LYRÆ, 3 LYRÆ (Flamsteed's number), and Groombridge 2616, the latter catalogue being arranged in order of Right Ascension, no notice being taken of the constellations.

Flamsteed arranged his stars by constellations, and numbered them according to their order in Right Ascension —a convenient form for reference, as the stars follow a regular sequence. Occasionally, however, stars numbered in order of Right Ascension, in course of time become displaced from this order, owing to the precession of the Equinoxes (or "precession," as it is termed for short). This happens if their Right Ascensions are nearly the same, and if they are widely different in Declination.

Constellation Boundaries.—These have never been definitely agreed upon, so that occasionally Flamsteed and others numbered stars in one constellation which in other catalogues or charts are included in a neighbouring constellation. Thus 24 and 26 Camelopardi of Flamsteed are included in Perseus in the present work. Occasionally, also, in assigning Greek letters, stars were included by mistake in *two* constellations. For example, β Tauri and γ Aurigæ are one and the same star. The same thing occasionally happens in star catalogues: Flamsteed, for instance, is known to have duplicated half a dozen stars.

II. NOTES ON ASTRONOMICAL TERMS.

The Star Sphere is an expression used for convenience in speaking of the heavenly bodies and their positions with respect to one another. The name is derived from the appearance presented by the heavens as seen from the earth, the earth being apparently at the centre of a vast hollow sphere, which makes a complete revolution every day, and to the inside surface of which the stars seem fixed—for they do not sensibly change their place relatively to one another, in spite of their daily revolution. Of course, only one-half of the star sphere can be seen, at the same moment, from any place on the earth.

The pivots, as it were, of this sphere—the celestial poles—are directly overhead at the terrestrial poles; and its equator—half-way between the poles—is directly overhead at the terrestrial equator, so that it is easy to measure the positions of the stars by saying they are so many degrees north or south of the celestial equator (called the stars' "Declination"), and so many degrees east or west of some meridian. The latter distance, however, is for convenience expressed in hours and minutes of *time* instead of degrees, as explained below, and is termed "Right Ascension."

Right Ascension.—The Right Ascension of a star (contracted "R.A.") corresponds to the longitude of a place on the earth's surface. The starting point is known as "The First Point of Aries," a point in the sky situated on the celestial equator, nearly as far *below* γ Pegasi as α Andromedæ is *above* it—stars forming one side of what is known as "The Great Square of Pegasus"—or a little below the small star ω of Pisces.

As the heavens circle completely round the earth once each day, it is easy to note how many hours, minutes, and seconds elapse between the time at which this point 'culminates' (*i.e.* attains its highest altitude above the horizon, see p. 7) and the time of culmination of any desired star. This interval is called the star's Right Ascension. Thus every star which culminates at the same instant as the "First Point of Aries," is said to have a Right Ascension of 0 hours, 0 minutes; all that culminate three hours later are said to have a Right Ascension of three hours, and similarly for any other interval, up to twenty-four hours, which is the same as 0 hours, 0 minutes. Strictly speaking, these hours, minutes, and seconds of Right Ascension are respectively very slightly shorter than the hours, minutes, and seconds of ordinary clocks, because the stars make a complete circuit of the earth in 23 hours, 56 minutes, 4 seconds, or in about four minutes less than a mean solar day. Observatories are provided with special clocks, regulated to keep this sidereal time, for reading off the exact instant of culmination, of planets, comets, &c., and thus finding their R. A.

In more scientific language, the First Point of Aries is the point in the sky at which the centre of the Sun crosses the celestial equator at the vernal equinox in March, but yearly it changes its position slightly among the stars, moving back on the Ecliptic $50\frac{1}{4}''$ of arc per annum (= about 3 seconds of R.A.), or a space equal to the apparent diameter of the Moon in about thirty-nine years. Though it retains its old name, it is no longer in the constellation of Aries but in that of Pisces. This is why star charts get out of date: the starting point of measurement is not fixed, and both the Declination and Right Ascension lines in the chart after a while no longer represent the actual positions with reasonable accuracy, especially near the Celestial Poles. This backward motion is '*precession.*'

Declination.—The Declination of a star (contracted "Dec.") corresponds to terrestrial latitude, and is measured by the number of degrees the star is north or south of the Celestial Equator, which is simply an extension, as it were, of the terrestrial equator as far as the star sphere. As already mentioned, at the terrestrial equator the celestial equator is directly overhead; and similarly at any latitude on the earth's surface, the stars with the same amount of Declination as the latitude will be directly overhead when culminating. The signs + and − are sometimes used instead of N. and S., to distinguish between North (+) and South Declination (−).

Stars with a *greater* declination than the co-latitude* of the observer never set, but are always above the horizon, if both observer and star are on the same side of the equator, or never rise if they are on opposite sides of the equator. Thus in latitude 50° north, all stars with declination north greater than 40° never set, and those with declination south greater than 40° never rise above the horizon.

* The difference of the latitude from 90°.

North Polar Distance.—Sometimes the latitude of a star is measured from the North Celestial Pole instead of from the celestial equator: in this case it is termed its 'North Polar Distance,' and ranges from 0° at the North Pole to 180° at the South Pole.

"Size" of a degree on the star sphere.—The following will be found useful for roughly estimating angular distances on the star sphere: others can easily be made up from the star charts. The degrees are those of a "great circle," such as degrees of declination, or degrees measured along the celestial equator:—

Half a degree = approximately the angular diameter of the Moon.
$1\frac{1}{4}$ degrees = approximately the angular distance between δ and ϵ ORIONIS.
2 ,, = ,, ,, ,, ,, ,, α and γ AQUILÆ.
$2\frac{1}{2}$,, = ,, ,, ,, ,, ,, α and β AQUILÆ.
4 ,, = ,, ,, ,, ,, ,, α and β CANIS MINORIS; or β and ζ CRUCIS.
5 ,, = ,, ,, ,, ,, ,, α and β URSÆ MAJORIS.

The Ecliptic, shown on star charts, indicates the path traced out by the centre of the Sun as it travels among the stars in its (apparent) annual circuit of the heavens. That is to say, if we could see the Sun and the stars behind it at the same moment, day by day we should find the Sun exactly following the line shown on the charts.

The Equinoctial is another name for the celestial equator.

The Zenith is the point in the sky directly over the observer's head; the *nadir* that directly below his feet.

The Zodiac is a belt of the sky, extending 8 degrees on each side of the Ecliptic, in which the Moon and the principal planets are always to be found. It is divided into twelve 'Signs,' each 30 degrees in length, denoted thus—

Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpio	Sagittarius	Capricornus	Aquarius	Pisces
♈	♉	♊	♋	♌	♍	♎	♏	♐	♑	♒	♓

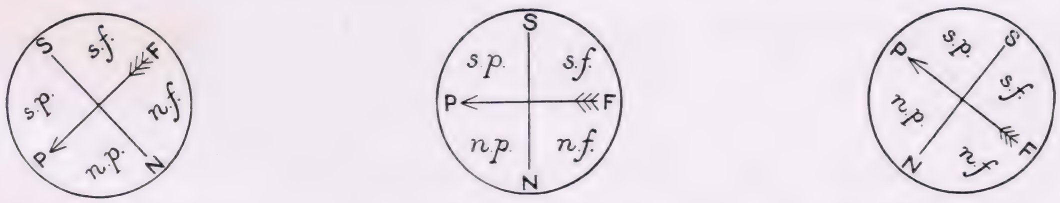
As the result of precession, the signs of the Zodiac do not now coincide with the *constellations* of the same name.

Culmination, &c.—A star is said to culminate when it reaches its highest point above the horizon of the observer. In the Northern Hemisphere this invariably takes place when the star is due south, in the Southern Hemisphere when it is due north. The phrases, 'on the meridian,' or 'returns to the meridian,' have the same meaning as culmination. In northern latitudes this is sometimes termed "Southing."

'Lower culmination' (used in connection with circumpolar stars only, *i.e.* stars which never set), indicates their position twelve hours after ordinary culmination, when *nearest* the horizon, at the opposite side of the celestial pole.

North Preceding, &c.—In describing how to find celestial objects, the often-used phrase "North (or South) Preceding," "North (or South) following," a certain star, means that the object is nearer the North or South celestial pole than the star referred to. "Preceding" means that its Right Ascension is *less* than, and "following" *greater* than, that of the reference star, and indicates the direction in which to find the required object.

Observers in the Northern Hemisphere must remember that in the inverted view of an object, as seen in astronomical telescopes (except "Gregorians," see p. 14), the upper part of the field of view is south, while the lower part is north. To observers south of the Equator, however, the reverse is the case.



Between rising and culmination. (*Angle depending on latitude of observer and declination of star.*) Southing or culminating. (*Upright.*) Between culmination and setting. (*Angle depending on latitude of observer and declination of star.*)

n. p. = North preceding. *n. f.* = North following. *s. p.* = South preceding. *s. f.* = South following. *P* = West. *F* = East.

Diagram showing direction of motion of a star across the field of an *inverting* astronomical telescope used in the Northern Hemisphere. In the Southern Hemisphere, hold the book upside down.

In the diagram, the arrow denotes the apparent path of a star as it crosses the field of view of a fixed telescope in the Northern Hemisphere. This path will be horizontal only when the object is on the meridian, but the relative positions remain unchanged.

Longitude.—This term, when used in astronomy, must not be confused with Right Ascension, from which it is quite different. Both Longitude and Right Ascension start from the First Point of Aries, but the former is measured (0 to 360 degrees) along the *ecliptic*; the latter along the *celestial equator*, in hours, &c.—1 hour being exactly equal to 15 degrees, and 4 minutes exactly equal to 1 degree. As the ecliptic lies at an angle to the celestial equator, the result is that a planet's movement of 1° in longitude does not exactly correspond to 1° (*i.e.* 4 minutes) in Right Ascension, partly because the direction of measurement is different, and partly because the respective degrees may be of different lengths on the star sphere—as, for instance, where the 'great circle' degrees of the ecliptic itself traverse the ever-narrowing Right Ascension degrees (*i.e.* 4 minutes) at Declination 20°.

The term 'longitude' is now only used astronomically in connection with planets and comets, and is the angle between the First Point of Aries and the foot of a perpendicular line drawn from the planet, &c., to the ecliptic. It is more convenient than Right Ascension for describing the circuit of planets round the star sphere, because all the principal planets follow the course of the ecliptic rather than the celestial equator.

Motions of the planets.—A planet is in *perihelion* (π) when it is at its nearest distance to the sun, and in *aphelion* when it has reached its greatest distance from it. *Perigee* is the point of the moon's orbit which is nearest the earth, and *apogee* that which is most distant from it; but the terms are sometimes applied to the planets in the same sense. Planets are in *conjunction* (☌) with the sun, moon, or another planet, when their longitudes are the same—Mercury or Venus being in *superior conjunction* with the sun when the conjunction occurs while they are on the far side of sun from the earth (*i.e.* the sun being between the planet and the earth), or in *inferior conjunction* if they are on the near side of the sun. 'Conjunction' is also sometimes used to denote similarity in Right Ascension.

Mars and the planets beyond—Jupiter, Saturn, &c., are in *opposition* (symbol ☍) when their angular distance on the star sphere away from the sun is 180° of longitude (or 12 hrs. R.A.), so that they are on the meridian about midnight; and in *quadrature* (□) when they are 90° of longitude (or 6 hrs. R.A.) from it, thus being on the meridian about 6 a.m. or 6 p.m. Planets are said to to be *stationary*, when their seeming movement east or west among the stars is changing to the reverse direction, and *retrograde* when their seeming motion among the stars is westerly instead of easterly. The *elongation* of a planet is its *angular* distance (*i.e.* its distance in degrees) from the sun as seen from the earth; the *greatest elongation* of Mercury or Venus being the time when this angular distance is at its maximum. *Transits* of Mercury and Venus occur when, from the earth, they are seen passing over the sun's disc.

When a planet, in its movement among the stars, reaches the ecliptic on the star sphere—that is, in reality, reaches the *plane* of the ecliptic—it is said to be at a *node* of its orbit. If it is passing from the north to the south side of the ecliptic, it is at the *descending node*, (symbol ☋); if the reverse, at the *ascending node* (symbol ☊). The nodes, in fact, are the points of intersection of the planet's orbit with the ecliptic.

Albedo.—The albedo of a planet, is its light-reflecting capacity per unit of area—actual, not angular area. It varies considerably, for, according to Zöllner, Mercury reflects ·13, Venus ·50, Mars ·27, Jupiter ·62, Saturn ·52, Uranus ·64, Neptune ·46, and the Moon ·174, of the light which they respectively receive from the sun. Other estimates of Venus are even brighter. The albedo of terrestrial clouds is estimated at about ·72.

Vertex.—The vertex of the moon, sun, or a planet, is the point on its 'limb' or edge furthest above the horizon of the observer. When measuring distances in degrees from the vertex, they are counted eastwards from 0° round to 360° again.

Colures.—These will be found marked on celestial globes, &c. The *equinoctial colure* is the great circle passing through the celestial poles and the First Point of Aries (or 'equinox' as it is otherwise called), and is the same as the circle of 0 hrs. and 12 hrs. of Right Ascension. The *solstitial colure* is the great circle of R.A. 6 hrs. and 18 hrs.

It may be noted here that the stars on celestial globes are reversed as regards left and right; because a globe necessarily represents the star sphere as seen from the *outside*, while we view the stars from the *inside* of the star sphere.

Star Magnitudes.—The brightest stars are said to be of the first magnitude; those less bright, to be of the second magnitude; those still less bright, to be of the third magnitude, and so on. Each magnitude is about $2\frac{1}{2}$ times as bright as the one below it, a standard first magnitude star (*e.g. Aldebaran, Altair*) being exactly one hundred times as bright as a standard sixth magnitude star—which last is the faintest that can be seen with the

naked eye. As, however, several first magnitude stars are much brighter than *Aldebaran*, it has been found necessary, in modern magnitude valuation on a scientific basis, to still further extend the range of magnitudes, a star of magnitude "0" being about $2\frac{1}{2}$ times as bright as one of magnitude 1, and one of magnitude *minus* 1, being about $2\frac{1}{2}$ times brighter than one of magnitude "0." Intermediate magnitudes are denoted in tenths; thus magnitude 3·0 is slightly brighter than 3·1, but less bright than 2·9. The brightest fixed star, *Sirius*, has a magnitude of –1·6. The Moon on the same scale is magnitude –12·2, Venus, the brightest of the planets, –4·28, and the Sun –26·6. (See Table on p. 3).

The sixth magnitude, as already mentioned, is about the faintest visible to the naked eye; the eleventh, in a three-inch telescope, and the seventeenth, in the most powerful telescopes yet constructed.

Star Catalogues.—These are very numerous and of every description—for stars, double stars, clusters, nebulæ, variable and coloured stars, &c., but are rather inaccessible to the ordinary observer, many being found only in the journals of scientific societies, and others being very expensive. A selection of the more important catalogues is given on p. 4; a long list will be found in Vol. II. of G. F. Chambers' 'Handbook of Astronomy.' For star magnitudes the best known works are Pickering's Harvard Photometry, the Revised Harvard Photometry and its supplement (1908)—which together contain the magnitudes, &c., of no fewer than 45,792 stars in both hemispheres—and Gould's Uranometria Argentina (Southern Hemisphere).

III. NOTES ON THE PLANETS, STARS, NEBULÆ, &c.

The Planets.—These cannot be inserted in star charts as their positions are continually varying, but the *Nautical Almanac*, or some other based upon it, or the lists in newspapers and magazines, give their Right Ascensions and Declinations from day to day, so that their places among the stars can easily be found.

The principal planets always keep within a few degrees on either side of the Ecliptic, and may be distinguished from fixed stars by the fact that they do not twinkle, except occasionally when very low down. They are denoted by the following symbols:—

Sun	Mercury	Venus	Moon	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
☉ or ○	☿	♀	☾	⊕ or ♁	♂	♃	♄	♅	♆

Mercury and Venus, which are nearer the Sun than the earth, are called the 'inferior planets'; Mars and the other planets beyond it are termed the 'superior planets.'

Mercury keeps so close to the Sun that it is not readily observed, its maximum greatest elongation from the Sun being only $27\frac{3}{4}°$. Even under the most favourable conditions, therefore, it is only visible for about two hours, at most, after sunset or before sunrise, and at a low altitude above the horizon, especially in higher terrestrial latitudes. It is best seen about the time of the equinoxes, when these coincide with its 'greatest elongations,' (see above). The disc of Mercury exhibits the same phases as the Moon, and varies in angular diameter from $4\frac{1}{2}''$ to nearly 13″.

Venus is the brightest of the Planets, and can sometimes be seen in broad daylight. In a small telescope, its chief interest is that it also has phases like the Moon—some of which can be discerned even with an opera-glass. The dazzling brightness of Venus renders observations of its surface-markings very difficult. It should be examined in the daylight, or as soon as possible after sunset or before sunrise. It appears brightest during the 'crescent' phase—as an evening star about a month *after*, and as a morning star about a month *before* its greatest elongation.

Venus attains a maximum elongation from the Sun of 47 degrees, and the angular diameter of its disc varies from 10″ to 65″. At its brightest it is about 12 times as bright as *Sirius*, the brightest fixed star.

Mars is not usually well seen in small telescopes, but at favourable 'oppositions,'—*i.e.* when the earth is on the line between it and the Sun, and the two planets are thus at their nearest to one another—dark green markings are discernible on the ruddy disc, and generally a white spot at one of the poles, probably due to snow. The most favourable oppositions occur at intervals of about fifteen or seventeen years (in 1894, 1909). In certain positions, Mars is seen slightly 'gibbous,' *i.e.* not fully illuminated, but in 'opposition' it presents a round disc. Angular diameter $3\frac{1}{2}''$ to 30″, and mean opposition magnitude – 2·25, or fully a half magnitude greater than *Sirius*.

Jupiter is a splendid object for small telescopes, 'parallel belt' markings being plainly visible on its disc, which is perceptibly elliptical in shape. The 'Great Red Spot' marking, 30,000 miles long, 7000 broad, discovered in 1878, was of a bright colour till 1881, when it began to fade away. In 1892 it was of a pale orange tint, but ill-defined, and invisible in small instruments. The spot is now (1910) invisible, but a faint bay or hollow in the belt still marks its position.

Jupiter's angular diameter varies from 28″ to 46″, and its mean opposition magnitude is $-2{\cdot}52$, or about twice as bright as *Sirius*.

Four of Jupiter's satellites, or 'moons,' are visible in an opera-glass, all being about magnitude 6; the others only in giant telescopes. Three of these satellites are eclipsed by Jupiter's shadow once every revolution, but they do not disappear instantaneously, as the motion is slow. Sometimes a satellite 'transits' or passes across the face of the planet, appearing at the beginning or end of the transit as a bright spot on a dark background (the 'limb,' or edge, of the planet's disc being darker than the centre), while at intermediate times it may disappear from view altogether, if the background happens to be similar in brightness and colour, or it may appear as a dark spot. The shadows of the satellites also transit the planet's disc, showing as dark spots, which are apt to be mistaken for the satellites themselves; sometimes both satellite and shadow may be seen transiting at the same time. Occultations, which occur when the satellites pass behind the body of Jupiter, are frequent, but generally of little interest.

The configuration of the larger satellites throughout the year is given in almanacs. They are numbered consecutively I., II., III., IV., in order of distance, I. being nearest the planet.

Saturn is also a magnificent object for a small telescope; faint parallel-belt markings may be discerned, but its special feature is its wonderful 'ring' system, divided into two by a hair-like dark line known as "Cassini's Division," just visible in a 2½ in. refractor when the rings are widely open. Other divisions of the ring can sometimes be seen in very large telescopes. At intervals of about fifteen years (from 1908) the rings present their edge to the earth, and become invisible for a short period. Saturn's angular diameter varies from 15″ to 20″, and its mean opposition magnitude is $-0{\cdot}93$—rather brighter than that of *Canopus*, the second brightest fixed star.

Saturn's brightest satellite, Titan, shines as a star of the 9th magnitude, and may be seen with a very small telescope, while four other satellites—Rhea, Iapetus, Tethys, and Dione—are within the reach of a 4-in. instrument, and may sometimes be glimpsed with an aperture of 3-in. or even less. They are of about the 11th magnitude.

Uranus appears as a star of the sixth magnitude to the naked eye. Its disc, having an angular diameter of only 3½″, and also its satellites, are only distinguishable in large telescopes.

Neptune can be seen with the aid of an opera-glass when its position is found by reference to an almanac and the star charts, but is a faint and uninteresting telescopic object. Its angular diameter is 2½″, and its magnitude at opposition 7·8.

The Asteroids, or Minor Planets, are mostly very minute. The positions of the largest are given in the *Nautical Almanac*. They are numbered according to their order of discovery, and are printed thus 36 though names are also given them. The brightest of the asteroids are about magnitude 6½ to 8 at time of opposition.*

*In 1892 it was decided to distinguish the asteroids provisionally by letters which were afterwards used in a doubled form AA, AB. The double alphabet has been used up, and recently discovered asteroids have been designated JE, JF, JG. The permanent number is assigned when the orbit has been determined. The numbered asteroids now amount to 674 (Jan. 1910).

Comets vary in brightness, most of them being visible only with the aid of a telescope. A comet is generally first discernible as a minute, faint, misty patch of light, so much resembling a nebula that it is only identified as a comet when found to be in motion, but sometimes even a very large comet escapes detection at first by approaching us in the line of the sun. The essential portion of all comets is the *coma* or head, the misty patch of light already mentioned. In addition a *nucleus* may develop as it approaches the sun, *i.e.* a bright flame-like or star-like appearance within the *coma*, and also a tail, or sometimes several tails—which always point more or less away from the sun, no matter whether the comet is approaching or receding from the sun. The tail usually appears as a curved hollow cone, decreasing in brightness as it widens out. Both nucleus and tail, when present, increase in size and brightness as the comet nears the sun, and decrease as it recedes from the sun; *envelopes*, or stratifications of the mist round the nucleus, especially on the side towards the sun, may also appear as the comet approaches perihelion. Neither nucleus nor tail, however, are necessarily present. Many comets are known to be connected in some way with meteoric showers. *Periodic Comets* are those which revolve round the sun and appear to us at more or less regular intervals.

New comets are denoted by the year in which they are discovered. Thus Comet *a* 1909, was the first discovered that year, and Comet *b* 1909, was the second, and so on. They may also be designated by the order in which they arrive at the perihelion; thus Comet V 1909, which means the fifth comet that arrived at perihelion during that year.

Meteors, or Shooting Stars, may appear in any part of the sky, but it is found that there are certain well-marked points on the star sphere from which showers of meteors come every year at regular dates, when the earth returns to the same part of its orbit. These showers are named from the constellation in which the 'Radiant Point' or 'Radiant' lies—so called because it is the point in the sky from which the meteors of the shower appear to radiate in all directions. Meteors are twice as frequent at 6 a.m. as at 6 p.m., because at the former hour we are facing in the direction of the earth's motion in its orbit, while in the latter we are facing to the rear. Radiants have not been inserted in the charts, but the following are a few of the principal showers that may be looked for, and the approximate position of their Radiant Points:—

Date of Shower.	Name.	Position of Radiant. R. A. h.	m.	Dec.	Date of Shower.	Name.	Position of Radiant. R. A. h.	m.	Dec.
Jan. 2–3	Quadrantids	15	20	53° N.	July 25–30	δ Aquarids	22	36	11° S.
,, 17	κ Cygnids	19	40	53° N.	Aug. 10–12	Perseids	3	0	57° N.
Feb. 5–10	α Aurigids	5	0	41° N.	Aug. 12–Oct. 2	α Aurigids	4	56	42° N.
April 20–22	Lyrids	18	4	33° N.	Aug.–Sept.	Lacertids	22	8	49° N.
May 6	γ Aquarids	22	32	2° S.	Oct. 2	Boötids	15	20	52° N.
,, 11	α Coronids	15	24	27° N.	Oct. 18–20	Orionids	6	8	15° N.
,, 30	η Pegasids	22	12	27° N.	Nov. 13–15	Leonids	10	0	22° N.
June–Sept.	γ Draconids	17	56	48° N.	Nov. 17–27	Andromedes	1	40	43° N.
July–Aug.	Cygnids	21	0	48° N.	Dec. 10–12	Geminids	7	12	33° N.
July 25–Aug. 4	α-β Perseids	3	12	43° N.					

Note.—The Perseids, Orionids, Geminids, and several other showers, are visible every year about the time given. The Leonids, or November Meteors, were plentiful in 1799, 1833 and 1866, being seen at their best at intervals of about 33 years. In 1900 the display was not brilliant, owing to the disturbance of their orbit by the planet Jupiter.

The Zodiacal Light is not well seen in temperate latitudes, except near the time of the equinoxes. It appears as a faint, hazy, conical, beam of light which follows the course of the ecliptic on the star sphere, for 90° or more from the horizon where the sun has set (in spring), or will rise (in the autumn). It has been estimated as being, in its brightest parts, two or three times as luminous as the Milky Way, and is most probably due to sunlight reflected from meteoric bodies revolving round the sun. Its brightness seems to vary from time to time, and towards its extreme limits it is always exceedingly faint. Owing to its vertical, or almost vertical, position and the short duration of twilight, it is brighter when observed within the tropics than in temperate latitudes.

The Gegenschein or 'counterglow' is very difficult indeed to see; it appears as a *very* faint round patch of light, 10° to 20° in diameter (*i.e.* larger than the 'Great Square of Pegasus' = α, β, γ, PEGASI and α ANDROMEDÆ), situated on the ecliptic at the point diametrically opposite to where the sun is for the time being. The best

chance of seeing it is on a moonless night of exceptional clearness, when the ecliptic is highest above the horizon, viz., in December and January, but it cannot be distinguished if projected on the Milky Way. It also is possibly due to sunlight reflected from meteoric bodies.

The Milky Way* extends like a girdle right round the star sphere. Between CYGNUS and SCORPIO it forms two narrow parallel bands; thereafter for a considerable distance it is very much broken up and complex in form, but brighter. When CANIS MAJOR is reached it becomes a single but fainter band, until in CYGNUS it is joined again. The telescope shows that it is composed of myriads of minute stars, of the tenth and eleventh magnitude on the average.

There is a remarkable gap (starless to the naked eye) in the Milky Way, near the foot of CRUX, in the Southern Hemisphere, to which the name of 'The Coal Sack' has been given: it presents the appearance of a dark abyss in the midst of the surrounding brightness. There is a similar but smaller starless gap in CYGNUS, and others elsewhere.

The Magellanic Clouds, or *Nubecula Major* and *Nubecula Minor*, appear to the naked eye like detached portions of the Milky Way, and are a marvellous sight in the telescope, being made up of nebulæ and star clusters, both regular and irregular in shape. Their respective positions are R.A. 5h. 30m., Dec. 70° S., and R.A. 0h. 50m., Dec. 73° S., and they are therefore not visible from the latitude of Europe or the United States.

Double Stars are stars which to the naked eye appear as a single point of light, but when viewed through a telescope are found to be composed of two stars—or more, in the case of triple, &c., stars. Where one of the stars is of a much smaller magnitude than the other it is often styled a *comes* (plural *comites*) or companion.

Binary Stars are double stars which have been proved to revolve round a common centre of gravity.

Variable Stars are those which wax and wane in intrinsic brightness. Except in some southern constellations, the principal ones are frequently distinguished in star nomenclature by the Roman capital letters at the end of the alphabet, R, S, T, &c., the double form RR, RS, RT, &c., being used after Z is reached. (See note, top of p. 4).

Novæ, or New Stars, are stars which suddenly blaze out in places where no star visible to the naked eye has been known before, and then gradually fade away. They are designated by the year in which they appear, thus, *Nova*, 1866. If more than one appears in any year, they are numbered *Nova* 1, *Nova* 2, and so on.

Star Clusters are portions of the sky in which the stars are crowded very closely together.

Nebulæ are faint, misty, patches of light, usually of irregular form. Some of these have been resolved by the most powerful telescopes into patches of exceedingly minute stars; others are known to be masses of incandescent gas. *Planetary Nebulæ* are circular in form—so called because they much resemble the disc of a planet as seen in a telescope.

Occultations take place when the moon or a planet passes directly between us and some other heavenly body, shutting it out from view. Occultations of stars by the moon are frequent, and their times are given in almanacs: the disappearance always takes place on the east side of the moon and the reappearance on the west. Where the star occulted is bright, the disappearance and reappearance, being instantaneous, are of great interest. *Eclipses* of satellites, as distinguished from occultations, take place when they enter the *shadow* of their planet, and become invisible merely because the sun no longer shines on them, although nothing intervenes between them and us.

Eclipses.—*Total* and *annular* solar eclipses are so rarely visible from any given place that they need not be described in detail. Under the most favourable conditions, about three to four hours elapse between first and last contact, but the total phase never exceeds eight minutes in a total eclipse, or 12½ minutes in an annular eclipse, and is usually much less. At the equator, both totality and contact interval last about a quarter longer than at latitude 50°.

Partial solar eclipses are of little interest unless nearly total. In a small telescope, the sun appears as if it had a circular notch of greater or less size cut out of it.

Lunar eclipses, when total, last about four hours, from first to last contact, of which totality is for about two hours. Through the telescope, the earth's shadow may be seen sweeping slowly across the moon's disc, but its edge is not sharply defined. Usually the moon does not altogether disappear from view, even at mid eclipse, but shines with a dull reddish-orange light, being illuminated by sunlight refracted by the earth's atmosphere: the colour and brightness of the illumination depend on the amount of water vapour and clouds present in the earth's atmosphere at the time.

The *umbra*, in solar and lunar eclipses, is the dark shadow on that portion of the earth or moon which, for the time being, receives no direct light from the sun. The umbra shades away into the bordering *penumbra*, or partial shadow, which covers those regions whence the sun would be seen partially eclipsed.

* See Index Maps.

The Sun, as an object for small telescopes, is of little interest unless sunspots are visible: special precautions are required in observing it so as not to injure the eyesight (see p. 18).

In large telescopes the disc of the sun presents a granular or 'rice-grain' appearance. Even in a small telescope of 2 or 3 inches aperture, the surface of the sun will shew a mottled appearance, when the air is steady and definition good; but this mottling is of a coarser texture than that delicate granular appearance seen under higher powers with large instruments. *Faculæ, i.e.* irregular patches somewhat brighter than the average, may generally be seen. They are found on every part of the disc, but are best seen near the 'limb' or edge of the sun's disc, owing to the decrease in brilliancy of that part, arising from the sun's absorbent atmosphere.

Sunspots vary in size from small 'pores,' as the smallest are termed, to groups so large as to be occasionally visible to the naked eye. They present the appearance of a dark irregular spot, or *umbra*, surrounded by a less dark portion, or *penumbra;* the *umbra*, however, is only apparently dark, by comparison with its surroundings, being actually brighter than the electric arc. Sunspots are never seen at the sun's poles, and rarely at its equator, but are mostly confined to zones extending about 20° on each side of the solar equator. They wax and wane in number and intensity, at times none being visible, attaining a maximum or minimum about every eleven years, with some intermediate minor fluctuations. Special interest attaches to them from the fact that there is a connection between them and terrestrial magnetism—as yet unexplained.

The sun's rotation may be traced day by day by the apparent motion of the spots across the disc, the rotational period being about 25 days near the equator, and 27 days at 45°. Spots may thus be visible for almost a fortnight at a time. Occasionally they are visible as a small notch on the sun's edge, when just coming into view from the far side of the sun.

Prominences or *protuberances* are jets or clouds of glowing red gas which rise all round the sun's 'limb' or edge. They can be seen only during total eclipses, or by means of a spectroscope attached to the telescope. (See p. 18).

The Corona, also seen only during total eclipses, is a mysterious, irregular, pearly halo of light surrounding the sun. It is never quite the same, either in shape or extent, in successive eclipses, and appears to be partly gaseous, and partly meteoric, for it shines partly by reflected sunlight.

The Moon is the most interesting of all the heavenly bodies for a small telescope. In an opera-glass the dark portions visible to the naked eye are seen to be the smoother portions of the moon's surface, the remainder of the surface is a mass of craters of every size, from some of which brilliant white streaks radiate for a great distance.

The best time for viewing the moon is when it is about its first or last quarter, as the lunar mountains near the *terminator* (or boundary between the bright and dark portion) then cast long sharp shadows which give a fine effect of contrast with the bright portions. At the time of full moon this contrast is lost. A low power should be used in the first instance for a general view.

The moon always presents the same side to the earth, so that one side of the moon is never seen at all. Owing, however, to what is termed the moon's *libration*, or apparent swaying, owing to the inclination of its axis to its orbit, and to other causes, we sometimes see a little more on one side or another, so that altogether about six-tenths of the surface is visible at one time or another. A full description of the moon with its great wealth of details is quite beyond the scope of the present work, but the following paragraphs, together with the sketch-map (see frontispiece) indicate the principal features.

Lunar *plains*, the darker and smoother portions of the surface, were supposed by the early telescopists to be *seas*—which they much resemble under very low powers—and were named accordingly. More perfect instruments, however, revealed that the supposed seas were simply vast plains, by no means level, or smooth, possibly once the bottom of lunar oceans.

Lunar *mountain ranges* and peaks are much higher in proportion to the moon's diameter than terrestrial ranges are to the earth's diameter, some of them attaining a height of about five miles. The most conspicuous range is *The Apennines*, in the northern hemisphere of the moon, which rises like a wall from the *Mare Imbrium*. It is about 600 miles long, and its highest peaks attain a height of 3½ miles—the heights being found by measurements of their long sharp shadows, nearly 100 miles long.

Lunar *craters*, which are such a prominent feature in lunar landscapes, are of all sizes from a hundred and fifty miles in diameter downwards. Craters proper have one or more conical peaks within the crater walls, of which *Tycho* and *Gassendi* are fine examples; those which have a smooth level bottom, without central peaks, and with

lower bounding walls than the craters proper, are called *walled plains*, of which *Plato* is the best example. The interiors of the craters are usually lower than the surface outside, but sometimes the reverse is the case. Frequently an old crater will be seen that has been broken into by a later one.

Lunar *rills* are deep, winding, narrow valleys, resembling the bed of a dried up stream. Lunar *clefts* appear like cracks on the smoother portions of the surface. It is difficult to realise that these hairlike markings are sometimes fifty or a hundred miles long and up to 2½ miles in width. The greater number of clefts are to be seen only in pretty powerful telescopes. *Faults* are closed cracks in the moon's surface, and are numerous. They are visible owing to the surface on one side of them being higher than that on the other.

Lunar *rays* are the bright streaks which radiate from some of the principal craters. Unlike other lunar features, they are best seen about the time of full moon. The finest system of rays radiates from the great crater *Tycho*, in the southern lunar hemisphere. The strangest feature of these rays is that they are everywhere on the same level as the rest of the surface, and traverse unbroken both crater walls, valleys, and seas. No fully satisfactory explanation of their nature has yet been given.

IV. THE CARE AND USE OF THE TELESCOPE.

THE following brief notes are given in the hope that they may be of use to the inexperienced observer:—

Telescopes are of two kinds—refracting and reflecting. Both varieties are rated according to their "aperture," as the *clear* diameter of the large lens in refracting telescopes, or of the mirror in reflecting telescopes, is called.

The larger the aperture, the more powerful the telescope in rendering visible faint objects; and, as this power increases in proportion to the *square* of the diameter, a telescope of 3 inches aperture is more than twice as powerful as one of 2 inches, while a 4-inch aperture is nearly twice as powerful as a 3-inch, or four times as powerful as a two-inch one—the actual ratios being 4, 9, 16. For astronomical purposes, a 3-inch telescope may be considered as about the smallest that can be used with satisfaction, though pleasing views of many objects may be obtained with even smaller telescopes of good quality.

THE REFRACTING TELESCOPE.

The astronomical refractor essentially consists of two convex lenses—(i) a large one of considerable focal length, known as the *object glass*, which forms at its focus an image of the distant star or other object, and (ii) a small lens of much shorter focal length: this is called the *eye-piece*, and is used to magnify the image formed by the object glass.

The Object Glass.—This is the most important part of the telescope, as its excellence depends on the accuracy of the curves of the lenses, the highness of their polish, and their transparency. In all astronomical telescopes worthy of the name, the object glass is "achromatic;" that is to say, it is composed of two (sometimes three) lenses of equal size but made of glasses of different density. These are so proportioned as to form an image almost free from the false colours, which are inevitably present when a bright object is viewed through an object glass consisting of a single lens. A good object glass requires to be treated with the most scrupulous care, and the notes on the care of the telescope on p. 17 should be carefully followed.

THE REFLECTING TELESCOPE.

In this form of telescope a large, concave, parabolic-curved mirror takes the place of the object glass of the refracting telescope.

The large mirror is held in a cell at the lower end of the large tube. The rays of light from the object pass down the tube and are reflected back. The reflected, convergent rays are intercepted—

(1) In the "Newtonian" form of telescope by a small, elliptical, plane mirror, or "flat," which reflects them at right angles through the side of the telescope to the eye-piece.

(2) In the "Gregorian" form by a small concave mirror, or (3) in the "Cassegrainian" form by a small convex mirror, which reflects them back again, through a hole in the centre of the large mirror, to the eye-piece.

The Newtonian and Cassegrainian forms give an inverted image, similar to that of the refracting telescope: the Gregorian, however, gives an erect image.

EYE-PIECES.

As already mentioned, these are used to magnify the image formed by the object glass, or the large mirror. For very high powers, and in special cases, a single lens is sometimes used; but generally an eye-piece consists of two lenses, mounted in a short tube which screws or slips into the focussing-tube of the telescope. There are several varieties, but the most common are:—

The Huyghenian or negative eye-piece.—This is the most common form, and consists of two plano-convex lenses, having their flat surfaces towards the eye.

The Ramsden or positive eye-piece.—Which gives a 'flatter' field than the Huyghenian (*i.e.* the field of view visible through it is not so blurred around the edges when the centre is sharply focussed), and, when of achromatic construction, performs excellently on planets.

As seen in an astronomical telescope with either of these eye-pieces, an object is inverted. To make it appear the right way up involves the use of additional lenses, which means some loss of light and a slightly fainter image, without any compensating gain.

The magnifying power of a telescope depends entirely upon the ratio of the focal length of the object glass to that of the eye-piece: thus, with an object glass of 36 inches focal length, and an eye-piece having a focal length of $\frac{1}{2}$ inch, the magnifying power will be 72 diameters, or "power 72" as it is termed.

It is advisable to have at least three eye-pieces of different power:—

(1). One of low power with a large "field," (that is, showing a considerable area of the sky), for viewing comets, large and scattered clusters, and extended nebulæ, magnifying 8 or 10 times per inch of aperture. Thus, on a 3 in. telescope the power may be from 25 to 30.

(2). One of moderate power, magnifying 25 or 30 times to each inch of aperture.

(3). One of high power, magnifying 50 or 60 times to each inch of aperture.

When experience has been gained, the observer may sometimes use eye-pieces of still higher power, but, as a rule, to advantage only on close double stars, when the telescope is of excellent quality and the atmospheric conditions are most favourable. The extreme limit of useful power is about 100 diameters per inch of aperture. It must be remembered that, as the power is increased, a corresponding apparent increase takes place in any defects of the telescope, the vibrations of the stand or ground, the rate of motion of a star across the field, and of atmospheric disturbances.

To find the focal length of the object glass or mirror.—Remove the eye-piece, and stretch a piece of semi-transparent paper over the end of the draw-tube. Point the telescope at the sun, and focus the sun's image on the paper screen. The measured distance between the back of the object glass and the screen is, for practical purposes, the focal length of the object glass. In the Newtonian Telescope, the distance is measured from the centre of the surface of the large mirror to the centre of the surface of the flat, and thence to the screen, placed as above.

To find the focal length of a Huyghenian eye-piece.—Divide twice the product of the focal lengths of the two lenses by the sum of their focal lengths: the quotient is the focal length of an equivalent single lens.

To find the power of an eye-piece.—Make a scale with plainly-marked equal divisions. Set this up at a considerable distance away, and, holding both eyes open, view the scale through the telescope with one eye and directly with the other. The number of divisions on the scale, covered by the magnified image of one of them, is equal to the magnifying power of the eye-piece used. For measuring low powers, a distant brick wall will take the place of the scale.

Another method.—Focus the telescope on a star. Next morning, without altering the focus, point the telescope to the bright sky. When the eye is placed about 10 inches behind the eye-piece, there will be seen a small, clearly-defined disc of light. Measure the diameter of this disc by means of a Berthon Dynamometer (see p. 17) placed against the eye-piece—a pocket lens, of low power, should be used as an aid in doing this. The magnifying power of the eye-piece is found by dividing the clear diameter of the object glass by the measured diameter of the bright image.

Diameter of field.—To ascertain the diameter of the field of an eye-piece, observe how long a star situated

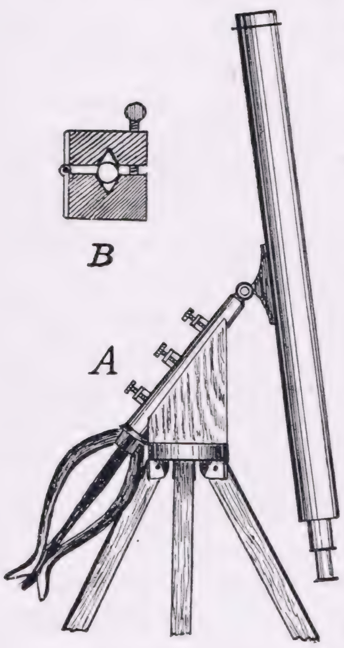
near the equator (*e.g.* δ ORIONIS) takes to pass centrally across the field from one side to the other. This time, expressed in minutes and seconds, when multiplied by 15, will give the diameter of the field in minutes and seconds of arc.

TESTS.

The actual performance of a telescope on a celestial object is the only really satisfactory test. Seen through a telescope bearing its highest power, a fixed star of the second magnitude should appear as a minute, well-defined, circular disc of light, almost a point, and surrounded by one or two thin, concentric, bright rings. There should be no false rays of light, and the rest of the field should be uniformly dark. The telescope should not, however, be condemned too hastily, as an inferior eye-piece, or the state of the air (see p. 17), may be responsible for apparent defects in the object glass. A close double star with very unequal components forms a most severe test. A telescope of the finest quality should separate a double, consisting of two 6th magnitude stars, whose distance from centre to centre in seconds of arc is equal to 4·56 divided by the aperture expressed in inches: thus, a 3-inch telescope should just divide a double star whose components are 1·52″ apart.

ACCESSORIES.

Stands.—Much depends upon the rigidity of the telescope stand, and good observations must not be expected from the open window of an ordinary room, as the vibration of the floor, and the mixed currents of air, set the object being viewed dancing. For small telescopes, the ordinary, alt-azimuth, tripod garden stand is most convenient. An iron pipe of about 4 inches diameter, partly sunk in the ground, and rammed full of clay to deaden vibration, forms a good support for a telescope of moderate size.



Improvised Equatorial.

The "equatorial" stand is of enormous advantage, but is rather expensive. It has one of the pivots, or axes, which carries the telescope, directed towards the celestial pole, (being adjustable for latitude). The result is that a star may be followed by a single circular movement of the telescope, instead of the instrument having to be moved both in altitude and azimuth.

A tolerably satisfactory makeshift can be arranged (in the higher latitudes at least) with an ordinary tripod stand, by setting one leg to the pole-star, and then adjusting the other legs so that the *pillar* of the telescope is tilted over to point to the pole-star.

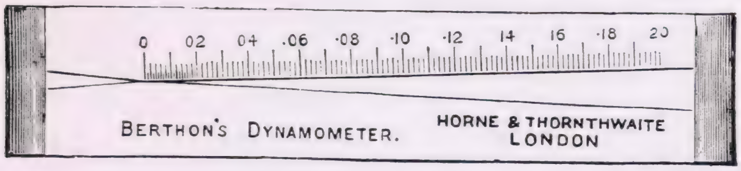
Or still better, by screwing on to the top of the stand a block of wood which is cut off at an angle, as shown in the illustration (A), and which has a V-groove, with sides at an angle of 60°, cut along the inclined face, for receiving the pillar. The claw legs of the stand, folded up, will act as a counterpoise, and two or three screw clamps will keep the pillar firm. A piece of hard wood (not shown in the illustration), also V-grooved, should be interposed between the point of the screws and the pillar, to prevent damage when tightening up the screws. A somewhat simpler construction is to hinge this upper block at one side to the lower block, and pass the screws through both blocks at the other side, as shown in the illustration at (B).

The angle of the sloping top, from the vertical, must be the latitude of the observer subtracted from 90°. Thus, for latitude 52° it will be $90° - 52° = 38°$.

Finder.—A finder is a small telescope fixed by supports to the body of the larger instrument. When high powers are used, this adjunct is a necessity, and in all cases it adds much to the comfort of observing. The finder may be roughly adjusted by day on a distant weather-cock or some other definite object. To improve the adjustment, bring the polar star into the centre of the field of a low power eye-piece on the large telescope; then alter the direction of the finder, by means of the adjusting screws, until the star image is in the centre of the field of the telescope, and also bisected by the cross wires of the finder at the same moment. Now replace the low-power eye-piece by one of high power, and perfect the adjustments in the same way. For small telescopes up to 3-inch, 'sights' similar to those on rifles can be arranged (painted white), which will be found of some service.

Dew-cap.—To guard against the deposition of dew on the object glass, make a tube of tin, cardboard, or some such material, about 9 inches or 1 foot long, and of such a diameter as to fit closely, but not too tightly, on to the object glass end of the tube. The inside of the dew-cap should be covered with black velvet, or painted with a mixture of lamp-black and size.

Berthon's Dynamometer (or measuring gauge) is a little instrument used for measuring the diameters of small objects. It has two flat metal sides, the internal straight edges of which meet towards the end, and are inclined to each other at a small angle. One of the edges is graduated from 0 to $\frac{2}{10}$ of an inch. The figures on the scale denote the width of the gap between the two straight edges. To measure the diameter of any small object by means of this little appliance, it is only necessary to see at what part of the scale the object *just* fills the space between the internal edges of the gauge, and then take the reading from the scale. The scale is divided into 20 long divisions of ·01 or hundredths of an inch These are subdivided into five parts each equal to ·002 or five-hundredths of an inch. The first two long divisions are again divided into parts equal to ·001 or thousandths of an inch. The price is 7/6.



HINTS ON CLEANING.

Refracting Telescope.—A good object glass is so delicately figured that it should be cleaned as rarely and carefully as possible, for fear of affecting the accuracy of its form. (*See below, "Cleaning."*)

The lenses should never be taken out of their cell by an inexperienced person.

The object glass should be held in its cell with just sufficient "play" for a slight rattle to be heard when it is gently shaken. If screwed up tightly, it causes strains in the glass which mar the perfect definition.

Reflecting Telescope.—The silvered mirror requires to be kept with very special care, as the silver is exceedingly liable to tarnish, especially in or near large towns, from the sulphurous fumes in the air. The owner of a reflecting telescope should, therefore, procure and study the "Hints on Reflectors," which have been published by several of the leading makers of these instruments.

A slight stain causes merely an inconsiderable loss of light, but, if badly tarnished, the mirror must be re-silvered. This process may be successfully accomplished by the amateur, with little difficulty, and at no great expense, if he carefully follows the directions given in the books just referred to, and uses pure chemicals.

Care of the Telescope.—Before removing the telescope after the night's work, cover the object glass or mirror with the metal cap provided for that purpose.

Never take the instrument from the cold outer air into a warm room, or the object glass will become dewed. If this should happen, the object glass must not be left in that state; but it should be placed in a warm room, at a safe distance from a fire, until the moisture has vanished. Any stains left on the glass must be removed by gentle polishing. Never wipe an object glass when it is damp.

Cleaning the Lenses.—When it becomes necessary to clean these, any dust should first be removed by means of a *camel's-hair brush.* Then the lens should be wiped very gently with a piece of very fine and clean wash-leather or silk.

When not in use, all brushes and materials employed for this purpose should be carefully protected from dust by keeping them in clean stoppered bottles or air-tight cases.

HINTS ON OBSERVING, &c.

Atmospheric Conditions.—To get the best results, objects should be viewed when they are as far as possible above the horizon, *i.e.* when near culmination. Satisfactory observations cannot be made of objects at low altitudes, owing to the increased intervening thickness of the atmosphere, and the haze and mist which so often obscure the horizon. The nights when the sky is darkest, and the stars most brilliant, are by no means always the best for observational purposes. Faint and ill-defined objects, such as some nebulæ, may, however, often be seen to advantage on nights of this class.

When the stars twinkle much it is an indication that the air is unsteady and not altogether satisfactory for observation.

During a slight haze, the air is often very steady, and splendid views of bright objects may then be obtained.

Viewing Faint Objects.—The eye becomes much more sensitive to faint impressions after it has been kept in the dark for a considerable time.

Very faint objects, otherwise invisible, may sometimes be detected by averted vision: the eye is directed to another part of the field, while the attention is fixed on the spot where the object is supposed to be.

A slight change of focus is often restful to the tired eye.

Viewing the Sun.—It is extremely dangerous to attempt to view the sun unless proper precautions are taken: blindness may be the penalty of rashness or ignorance. A perfectly safe method is to support a smooth, white card, at the distance of about a foot from the eye-piece, and to focus the image of the sun projected on it. The screen should be held in a covered frame-work or box, and the picture of the sun viewed through a hole in one of the sides. If, on the other hand, the sun is viewed directly through a dark-glass cap, a larger aperture than 2 inches cannot safely be used in the heat of summer. A stop made of a card, with a circular hole of 2 inches or less in diameter, should be fitted over the object glass of a larger instrument, to reduce the amount of light and heat transmitted.

To see the prominences by means of the spectroscope, the edge of the sun's image should be made to fall on the nearly-closed slit of the spectroscope—which must be one of considerable dispersive power. The telescope should then be driven (preferably by clock-work) so as to keep the image in the same position. The spectroscope is next focussed on one of the hydrogen lines of the spectrum, and, on the slit being opened, the prominence will be seen. Good views may be obtained in this way, using a 3-inch telescope with a spectroscope having several prisms.

Comet-seeking.—In searching for comets, a telescope of fairly large aperture and of short focal length, with an eye-piece of low power having a large field of view, should be used. The observer should slowly 'sweep' (*i.e.* move the telescope in a horizontal direction) for some distance, a careful watch being kept all the time. At the end of the sweep the telescope is *slightly* raised or lowered, and an overlapping sweep is taken in the opposite direction. This process is repeated continuously. Should a nebulous-looking object be noticed, the comet-hunter must look in his catalogue of nebulæ to see if the object can be identified. If not, he should draw a careful sketch of its position among the neighbouring stars. If in the course of time any movement can be detected, and the place of the suspected object does not agree with that of any known comet, its position should be determined as accurately as means will allow, and a telegram giving particulars should be sent to the Astronomer Royal, Greenwich Observatory.

Making Notes, Consulting the Charts when observing, &c.—A bull's-eye lantern with a slide to shut off the light is of great use. A cycle lamp may be utilised by the occasional observer. It may be placed on a support at some distance from the observer, and so directed as to throw a *faint* light on the book or card, when notes or sketches are being made at the telescope.

A strong light should be avoided as it makes the eye less sensitive for observation.

A small table to hold the maps and other books, with a lantern having a shade to throw the light downwards, lest the direct rays of light should reach the eye, is almost a necessity.

All observations should be written down at the time when they are made. The notes should be clearly worded, and should have entered on them the year, month, day, hour, and minute of the observation, together with the aperture and power of the telescope and the state of the air.

LIST OF STAR NAMES.

Name.	=
Achernar	α Eridani.
Acrab, Akrab ...	β Scorpionis.
Adara	ϵ Canis Majoris.
Albireo	β Cygni.
Alchiba, Al-khiba	α Corvi.
Alcor ...	80 Ursæ Majoris.
Alcyone (a Pleiad) ...	η Tauri.
Aldebaran	α Tauri.
Alderamin	α Cephei.
Algeiba, Algieba	γ Leonis.
Algenib	γ Pegasi.
Algol	β Persei.
Algorab, Algorel, Algores ...	δ Corvi.
Alhena	γ Geminorum.
Alioth	ϵ Ursæ Majoris.
Alkaid (*Benetnasch*)	η Ursæ Marjoris.
Alkalurops	μ^1 Boötis.
Alkes	α Crateris.
Almak, Almach ...	γ Andromedæ.
Alnilam	ϵ Orionis.
Alphard (*Cor Hydræ*)	α Hydræ.
Alphecca, Alphekka	α Coronæ Borealis.
Alpheratz, Alpherat (*Sirrah*)	α Andromedæ.
Alphirk	β Cephei.
Alrai (*Errai*)	γ Cephei.
Alruccabah (*Polaris*)	α Ursæ Minoris.
Alshain, Alshairn ...	β Aquilæ.
Altair	α Aquilæ.
Alwaid	β Draconis.
Antares (*Cor Scorpionis*)	α Scorpionis.
Arcturus	α Boötis.
Arided (*Deneb Adige*) ...	α Cygni.
Arneb	α Leporis.
Asterope (a Pleiad) ...	21 Tauri.
Atlas (a Pleiad)	27 Tauri.
Azelfafage	π^1 Cygni.
Azimech (*Spica*) ...	α Virginis.
Baten Kaitos	ζ Ceti.
Bellatrix	γ Orionis.
Benetnasch	η Ursæ Majoris.
Betelgeux, Betelgeuze	α Orionis.
Canopus	α Argûs.
Capella	α Aurigæ.
Caph, Chaph ...	β Cassiopeiæ.
Castor	α Geminorum.
Cor Caroli ...	α Canum Venaticorum.
Cor Hydræ (*Alphard*) ...	α Hydræ.
Cor Leonis (*Regulus*) ...	α Leonis.
Cor Scorpionis (*Antares*)	α Scorpionis.
Cor Serpentis (*Unukalhay*)	α Serpentis
Cursa, Kursa ...	β Eridani.
Deneb, Deneb Aleet, Denebola ...	β Leonis.
Deneb Algiedi ...	δ Capricorni.
Deneb, Deneb el Adige (*Arided*) ...	α Cygni.
Deneb Kaitos shemali ...	ι Ceti.
Diphda (*Deneb Kaitos jenubi*)	β Ceti.
Dubhe	α Ursæ Majoris.
Electra (a Pleiad)	17 Tauri.
Enif, Eniph (*Fom*) ...	ϵ Pegasi.
Errai (*Alrai*)	γ Cephei.
Etamin, Etanin ...	γ Draconis.
Fom (*Enif*)	ϵ Pegasi.
Fomalhaut ...	α Piscis Australis.
Gemma ...	α Coronæ Borealis
Giedi	α Capricorni.
Gomeisa ...	β Canis Minoris.
Hamal	α Arietis.
Homam, Homan	ζ Pegasi.
Izar (*Mizar, Mirac*) ...	ϵ Boötis.
Kaïtain (*Okda*) ...	α Piscium.
Kaus Australis ...	ϵ Sagittarii.
Keid	40 Eridani.
Kelb al Rai, Celb al Rai	β Ophiuchi.
Kocab, Kochab ...	β Ursæ Minoris.
Kornephoros ...	β Herculis.
Kursa, Cursa ...	β Eridani.
Maia (a Pleiad)	20 Tauri.
Markab	α Pegasi.
Marsik	κ Herculis.
Mebsuta	ϵ Geminorum.
Megrez	δ Ursæ Majoris.
Mekab, Menkab, Menkar ...	α Ceti.
Menkalinan ...	β Aurigæ.
Merak	β Ursæ Majoris.
Merope (a Pleiad)	23 Tauri.
Mesarthim, Mesartim ...	γ Arietis.
Mintaka	δ Orionis.
Mira	o Ceti.
Mirac, Mirach ...	β Andromedæ.
Mirac, Mirach (*Izar*) ...	ϵ Boötis.
Mirfak, Mirphak	α Persei.
Mirzam ...	β Canis Majoris.
Mizar	β Andromedæ.
Mizar	ϵ Boötis.
Mizar	ζ Ursæ Majoris
Muphrid	η Bootis.
Nath	β Tauri.
Nekkar	β Boötis.
Okda (*Kaïtain*) ...	α Piscium.
Phakt, Phact ...	α Columbæ.
Phecda, Phekha ...	γ Ursæ Majoris.
Pleione (a Pleiad)	28 Tauri.
Polaris	α Ursæ Minoris.
Pollux	β Geminorum.
Prima Giedi ...	α^1 Capricorni.
Procyon ...	α Canis Minoris.
Pulcherrima	ϵ Boötis.
Ras Algethi, Rasalegti	α Herculis.
Ras Alhagua, Ras-al-hague	α Ophiuchi.
Rastaban, Rasaben	γ Draconis.
Regulus (*Cor Leonis*) ...	α Leonis.
Rigel	β Orionis.
Rotanev	β Delphini.
Sadachbia	γ Aquarii.
Sadalmelik, Sadalmulk	α Aquarii.
Sadalsud, Sadalsund	β Aquarii.
Secunda Giedi ...	α^2 Capricorni.
Scheat, Sheat	β Pegasi.
Schedir, Shedir, Schedar	α Cassiopeiæ.
Sheliak	β Lyræ.
Sheratan, Sharatain	β Arietis.
Sirius	α Canis Majoris.
Sirrah (*Alpheratz*)	α Andromedæ.
Skat, Sheat, Scheat	δ Aquarii.
Spica	α Virginis.
Sulaphat	γ Lyræ.
Svalocin	α Delphini.
Talitha, Talita ...	ι Ursæ Majoris.
Tarazed	γ Aquilæ.
Taygeta (a Pleiad) ...	19 Tauri.
Thuban	α Draconis.
Unukalhay (*Cor Serpentis*)	α Serpentis.
Vega, Wega	α Lyræ.
Vindemiatrix ...	ϵ Virginis.
Wasat	δ Geminorum.
Yed	δ Ophiuchi.
Zaurak	γ^1 Eridani.
Zawijah, Zavijava	β Virginis.
Zosca, Zosma	δ Leonis.
Zuben el Genubi	α Libræ.
Zuben el Hakrabi	γ Libræ.
Zubenesch, Zuben el Chamali, Zubenelg ...	β Libræ.

Telescopic Objects—Maps 1 & 2.

DOUBLE STARS.

η Cassiopeiæ. 0h. 44m. N. 57° 25′. A binary star. Period 196 years. Magnitudes 4 and $7\frac{1}{2}$. Distance 5·7″ (1903). Colours, yellow and pale red.

σ Cassiopeiæ. 23h. 55m. N. 55° 20′. A double star. Magnitudes $5\frac{1}{2}$ and $7\frac{1}{2}$. Distance 3″. A grand field with a low power.

β Cephei. 21h. 27m. N. 70° 15′. A 3rd mag. star with a bluish 8th mag. *comes*, 14″ distant.

ξ Cephei. 22h. 2m. N. 64° 15′. A double star. Mags. of components 5 and $6\frac{1}{2}$. Distance about 7″.

δ Cephei. 22h. 26m. N. 58° 0′. A fine double star. The brighter star varies from 3·7 to 5 mag. in a period of 5d. $8\frac{3}{4}$h. The companion is a 5th mag. blue star, 41″ distant.

ν Draconis. 17h. 30m. N. 55° 15′. A double star composed of two $4\frac{1}{2}$ mag. stars. Distance 62″.

ζ Ursæ Majoris (*Mizar*). 13h. 20m. N. 55° 20′. The middle star of the Great Bear's tail. A splendid double star with components of the 2nd and 4th magnitudes and 14″ apart. It forms with 80 (*Alcor*), about 11′ distant, a naked-eye pair. Several fainter stars are included in a large field.

α Ursæ Minoris (*Polaris*). 1h. 32m. N. 88° 50′. The Polar Star. In 1920 it will be about 1° 7′ from the north celestial pole, and in the year 2095 within 26′ 30″. It is a 2nd mag. star with a 9th mag. bluish attendant 19″ distant, a well known test for instruments of less than 3 in. aperture. Polaris can easily be found by means of the "Pointers," α and β Ursæ Majoris.

π^1 Ursæ Minoris. 15h. 35m. N. 80° 40′. A double star, north preceding ζ. Components of the 6th and 7th mags. Distance 30″.

VARIABLE STARS.

μ Cephei. 21h. 41m. N. 58° 25′. An irregular variable star "of a fine deep garnet colour." (Sir W. Herschel).

Nova Cassiopeiæ. 0h. 20m. N. 63° 40′. The New Star of 1572 which equalled Venus in brilliancy and then died away. The place should be carefully watched for a possible reappearance.

NEBULÆ & STAR CLUSTERS.

H. VI. 30 Cassiopeiæ. 23h. 53m. N. 56° 15′. A beautiful cluster of small stars. Grand neighbouring fields.

M. 52 Cephei. 23h. 21m. N. 61° 10′. An irregular cluster containing an orange-coloured star.

H. IV. 37. Draconis. 17h. 59m. N. 66° 35′. A remarkable, bluish, elliptic, planetary nebula. It lies near the N. Pole of the Ecliptic, between the Polar Star and γ Draconis.

M. 97. Ursæ Majoris. 11h. 10m. N. 55° 30′. A large, remarkable, planetary nebula with a faint disc, of the apparent diameter of Jupiter. The "Owl Nebula" of Lord Rosse: so called from its appearance in his great reflector.

MAP I

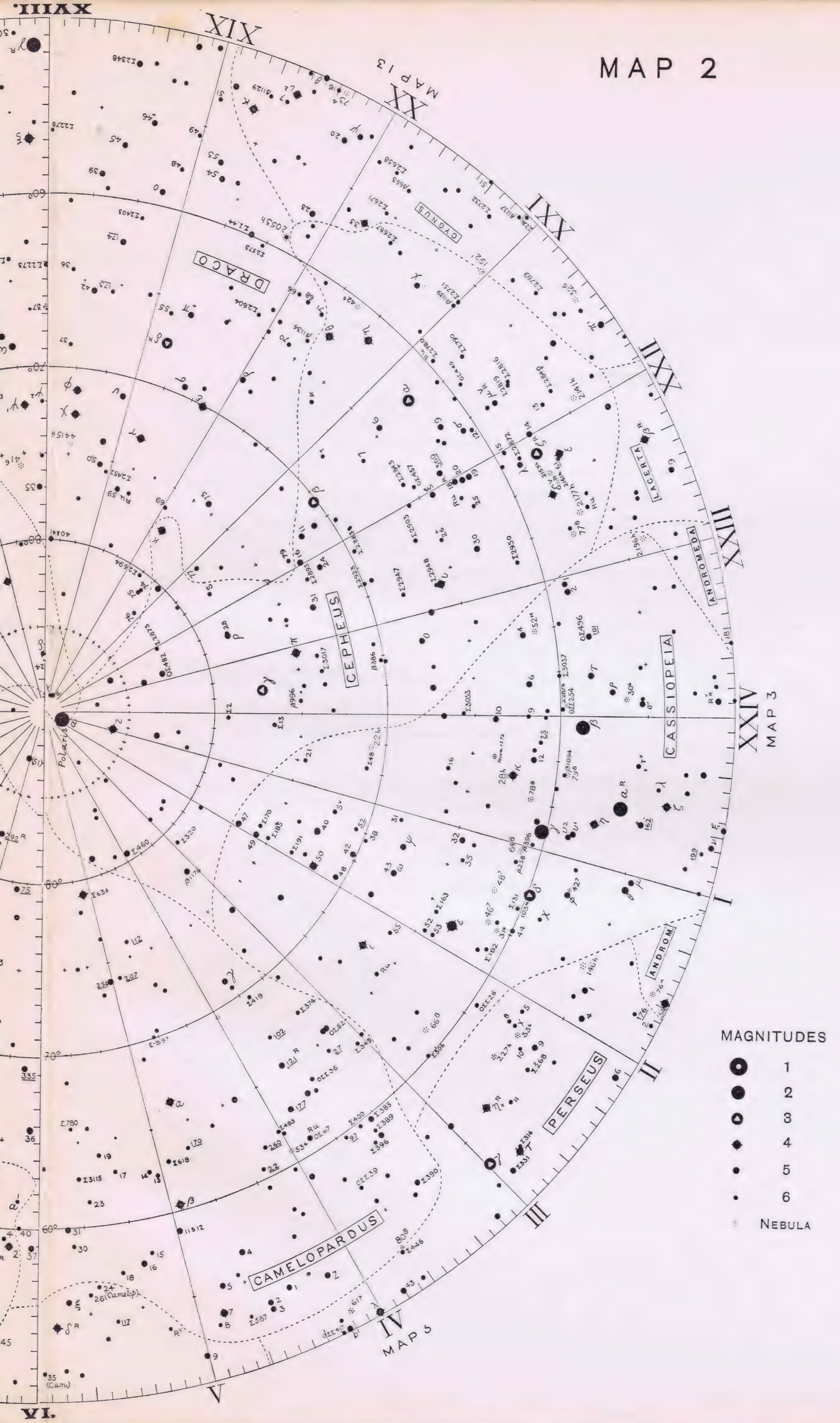
ANNO 1920.

ABBREVIATIONS

Greek letter (to a star,) Bayer's designation.
Small Roman letter „ „ „
„ capitals R to Z (to a star,) Variable stars.
Number only (to a star,) Flamsteed's number.
„ (to neb.,) Sir J. Herschel's No. (New Ed.)
Number underlined (to a star,) Piazzi's No.
Number with small no. to right of it. (to neb.,) Sir W. Herschel's number and class.

B.A.C. British Association number.
β Burnham's number.
Br. Brisbane's number.
Δ Dunlop's number.
E-B Espin and Birmingham's number.
H Sir W. Herschel's number.
h Sir J. Herschel's number.
Jac. Jacob's number.
Lac. Lacaille's number.
Ll. Lalande's number.
M Messier's nebulæ number.
OΣ Otto Struve's number.
OΣΣ Pulkowa Cat, Pt. II. No.
R or Ru. (small, to star) - Ruddy or yellow star.
Rus. Russell's number.
Sa. Santiago number.
St. Stone's number.
Σ F. Struve's number.
ΣI. Do. App'dix I. do.
V or Var. (small, to star) - Variable star.

MAP 2


DRACO
CYGNUS
CEPHEUS
LACERTA
ANDROMEDA
CASSIOPEIA
ANDROM
PERSEUS
CAMELOPARDUS
MAP 13
MAP 3
MAP 5
XIX
XX
XXI
XXII
XXIII
XXIV
I
II
III
IV
V
VI.
XVIII
Polaris
MAGNITUDES
1
2
3
4
5
6
NEBULA

Telescopic Objects—Maps 3 & 4.

DOUBLE STARS.

π Andromedæ. 0h. 32m. N. 33° 15′. A double star. Components of the 4th and 8th mags. Distance 36″.

γ Andromedæ. 1h. 59m. N. 41° 55′. A magnificent double star. An orange 3rd mag. star with a blue 5th mag., 10″ distant. The smaller star is itself a very close double. 1889, almost closed; 1902, 0·25″.

41 Aquarii. 22h. 10m. S. 21° 30′. A double star consisting of a reddish 6th. mag. star with a blue 8th mag., 5″ distant.

ζ Aquarii. 22h. 25m. S. 0° 25′. A very fine object in a small telescope. Its distance of 4·5″ in 1780 had closed to 3″ in 1892. Magnitudes 4 and 4·1. A binary star.

ψ^1 Aquarii. 23h. 12m. S. 9° 30′. A wide double star (50″). The brighter star is of mag. 4½, and yellow; the other 8½ mag., and blue.

8 Lacertæ. 22h. 32m. N. 39° 10′. A quadruple star, whose components are of the mags. 6, 6½, 10 and 9.

ϵ Pegasi. 21h. 40m. N. 9° 30′. A triple star, but only a wide double in small telescopes. Magnitudes 2½ and 9. Distance 140″.

π^1 Pegasi. 22h. 6m. N. 32° 45′. Forms with π^2 a fine wide pair.

η Pegasi. 22h. 40m. N. 29° 45′. A 3rd mag. star with a 10th mag. companion, 90″ distant. A test for a 3-inch telescope.

35 Piscium. 0h. 11m. N. 8° 20′. A double star. The components are of about the 6th and 7th mags. Distance 11·5″.

ι Trianguli. 2h. 8m. N. 29° 55′. A lovely double star. Its components are of mags. 5 and 6½. Distance 3·6″.

VARIABLE STAR.

o Ceti *(Mira)*. 2h. 15m. S. 3° 20′. A wonderful irregular variable star, which changes from 1½ to 9½ magnitude.

NEBULÆ & STAR CLUSTERS.

M. 31 Andromedæ. 0h. 38m. N. 40° 50′. The Great Nebula. Visible to the naked eye, preceding ν. In small telescopes, an oval, hazy mass. Photographs show it as a wonderful spiral.

H. VIII. 75, Lacertæ. 22h. 12m. N. 49° 30′. A fine cluster, with a beautiful field following it.

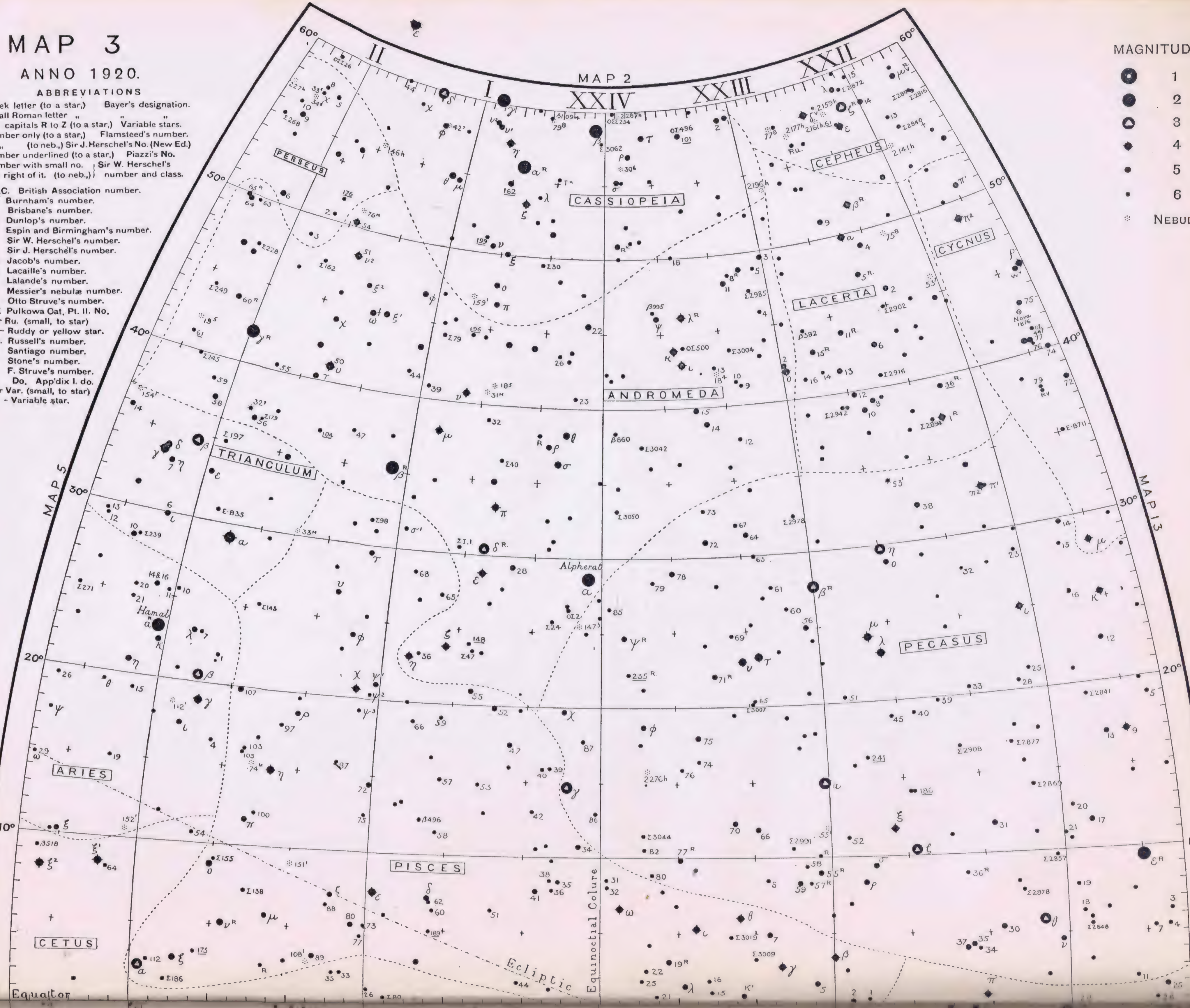
MAP 3

ANNO 1920.

ABBREVIATIONS

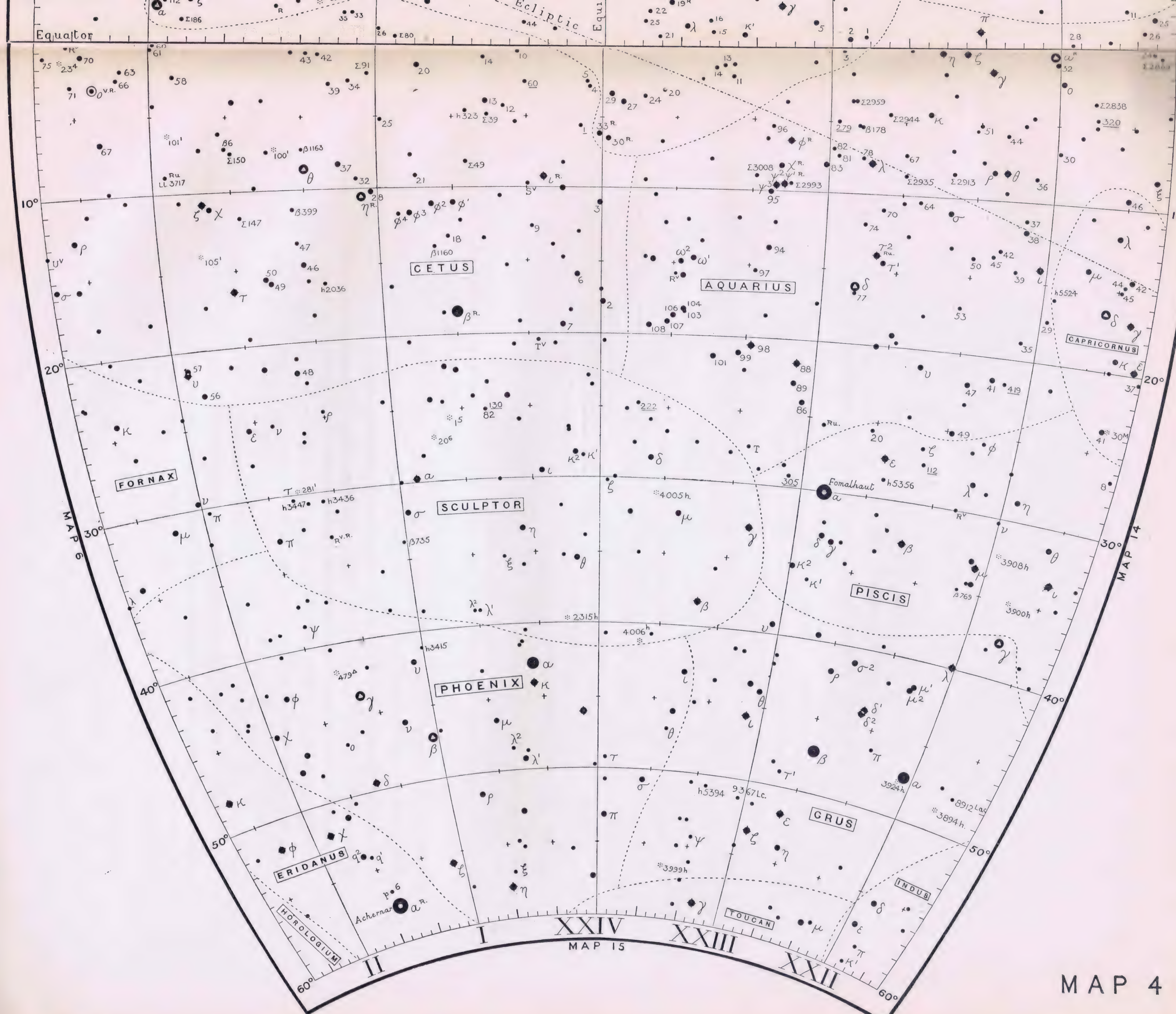
Greek letter (to a star,) Bayer's designation.
Small Roman letter „ „ „
„ capitals R to Z (to a star,) Variable stars.
Number only (to a star,) Flamsteed's number.
„ (to neb.,) Sir J. Herschel's No. (New Ed.)
Number underlined (to a star,) Piazzi's No.
Number with small no. to right of it. (to a star,) Sir W. Herschel's (to neb.,) number and class.

B.A.C. British Association number.
β Burnham's number.
Br. Brisbane's number.
Δ Dunlop's number.
E-B Espin and Birmingham's number.
H Sir W. Herschel's number.
h Sir J. Herschel's number.
Jac. Jacob's number.
Lac. Lacaille's number.
Ll. Lalande's number.
M Messier's nebulæ number.
OΣ Otto Struve's number.
OΣΣ Pulkowa Cat. Pt. II. No.
R or Ru. (small, to star)
- Ruddy or yellow star.
Rus. Russell's number.
Sa. Santiago number.
St. Stone's number.
Σ F. Struve's number.
ΣI Do. App'dix I. do.
V or Var. (small, to star)
- Variable star.



MAGNITUDES

1
2
3
4
5
6
Nebula


Equator
Ecliptic
CETUS
AQUARIUS
CAPRICORNUS
FORNAX
SCULPTOR
PISCIS
PHOENIX
GRUS
ERIDANUS
HOROLOGIUM
TOUCAN
INDUS
Fomalhaut
Achernar
MAP 6
MAP 14
MAP 15
XXIV
XXIII
XXII
I
II

MAP 4

Telescopic Objects—Maps 5 & 6.

DOUBLE STARS.

γ Arietis. 1h. 49m. N. 18° 55′. A double star discovered by Hooke in 1664. Magnitudes of each component, 4½. Distance 8·6″. A fine object.

γ Ceti. 2h. 39m. N. 2° 50′. A 3rd mag. yellowish star with a 7th mag. companion. Distance 2·6″.

32 Eridani. 3h. 50m. S. 3° 10′. A double star. The brighter component is of the 4th mag., and yellow: the fainter 6th mag., and blue or green.

γ Leporis. 5h. 41m. S. 22° 30′. A triple star. The chief components are of mags. 4 and 6½, and 93″ distant. A third faint star is 45″ from the 6½ mag.

β Orionis (*Rigel*). 5h. 11m. S. 8° 20′. A star of the 1st mag. with a bluish 8th mag. attendant, 9″ distant. Well seen in 2¼-inch Wray.

ι Orionis. 5h. 31m. S. 5° 55′. A double star. Magnitudes 3 and 7. Distance 11″.

σ Orionis. 5h. 34m. S. 2° 40′. A multiple star. The chief components are of the magnitudes 4, 10, 7½, and 7.

52 Orionis. 5h. 44m. N. 6° 25′. A double star, consisting of two equal 6 mag. stars at 1·5″ distance (1906). A hard test for 3 in.

η Persei. 2h. 44m. N. 55° 35′. A yellow 4th mag. star, with a blue attendant of 8½ mag. Distance 28″.

α Tauri (*Aldebaran*). 4h. 31m. N. 16° 20′. A star of the 1st mag. with an 11th mag. attendant, 109″ distant. A good light-test for a 3 in. telescope.

VARIABLE STARS.

β Persei (*Algol*). 3h. 3m. N. 40° 40′. The Demon Star. This notable variable has a period of 2d. 20h. 49m. Its usual magnitude for about 2½ days is 2½. In nearly 3½ hrs. it decreases to 3·6 mag., and after remaining at that for 18 or 20 minutes, in another 3½ hrs. it regains its former brilliancy.

NEBULÆ & STAR CLUSTERS.

M. 38. Aurigæ. 5h. 23m. N. 35° 45′. A grand cluster in a splendid neighbourhood.

M. 37. Aurigæ. 5h. 47m. N. 32° 30′. An extremely beautiful cluster of about 500 stars.

M. 42 Orionis. 5h. 31m. S. 5° 27′. "The Great Nebula in Orion," visible to the naked eye, is a fine object even in small telescopes. In its brightest part are four stars of 6, 7, 7½, and 8 mags., which form the well-known "trapezium." Two other stars have been glimpsed here in a 3-inch telescope.

H. VI. 33, 34. 2h. 15m. N. 56° 45′. The Cluster in the Sword Handle of Perseus. Two magnificent clusters, in the same field with a low power.

M. 1 Tauri. 5h. 30m. N. 22° 0′. This nebula was discovered in 1731, forgotten, and rediscovered by Messier in 1758. The discovery led him to make his catalogue of 103 nebulæ. The "Crab Nebula" of Lord Rosse.

The Pleiades. A beautiful naked-eye cluster of 6 or 7 stars, though some have made out 14, and even 16, without optical aid. *Alcyone* is the brightest star, 3rd mag. A very low power with a wide field should be used.

MAPS 5 AND 6

(R.A. II hrs. to VI hrs.)

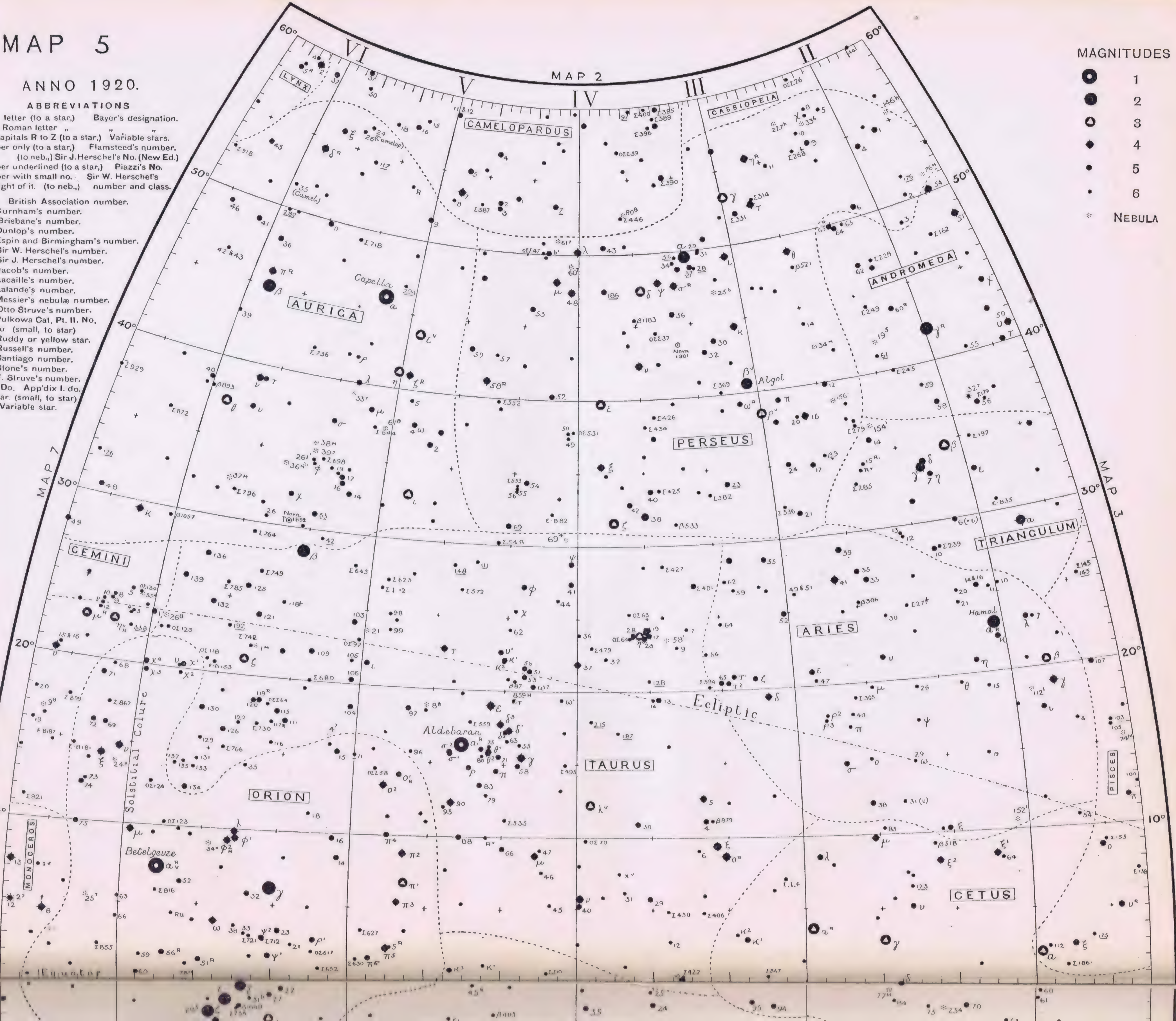
MAP 5

ANNO 1920.

ABBREVIATIONS

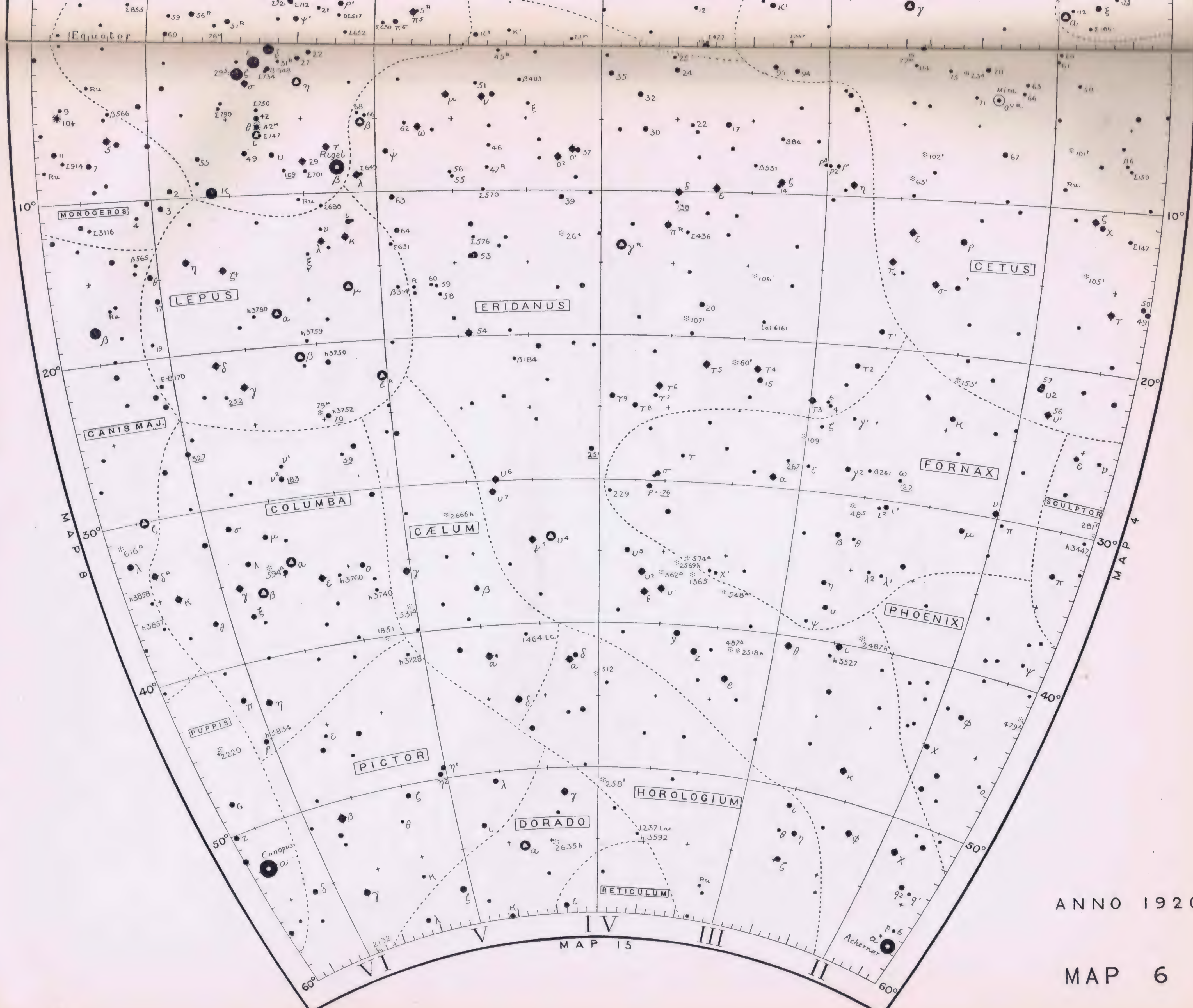
Greek letter (to a star,)	Bayer's designation.
Small Roman letter "	"
" capitals R to Z (to a star,)	Variable stars.
Number only (to a star,)	Flamsteed's number.
" (to neb.,)	Sir J. Herschel's No. (New Ed.)
Number underlined (to a star,)	Piazzi's No.
Number with small no. to right of it. (to neb.,)	Sir W. Herschel's number and class.

B.A.C.	British Association number.
β	Burnham's number.
Br.	Brisbane's number.
Δ	Dunlop's number.
E-B	Espin and Birmingham's number.
H	Sir W. Herschel's number.
h	Sir J. Herschel's number.
Jac.	Jacob's number.
Lac.	Lacaille's number.
Ll.	Lalande's number.
M	Messier's nebulæ number.
OΣ	Otto Struve's number.
OΣΣ	Pulkowa Cat. Pt. II. No.
R or Ru (small, to star)	Ruddy or yellow star.
Rus.	Russell's number.
Sa.	Santiago number.
St.	Stone's number.
Σ	F. Struve's number.
ΣI	Do. App'dix I. do.
V or Var. (small, to star)	Variable star.



MAGNITUDES

- 1
- 2
- 3
- 4
- 5
- 6
- NEBULA



ANNO 1920

MAP 6

TELESCOPIC OBJECTS—MAPS 7 & 8.

DOUBLE & MULTIPLE STARS.

h 273. ARGÛS. 7h. 35m. S. 26° 35′. A double star. Two 4th mag. stars at a distance of 10″.

5 ARGÛS. 7h. 44m. S. 12° 0′. A double star. The magnitudes of the components are 5½ and 7½, and their distance 3·3″.

ζ CANCRI. 8h. 7m. N. 17° 50′. A triple star. Magnitudes 5, 5½ and 5½. Distances 1″ and 5 5″.

α CANIS MAJORIS *(Sirius)*. 6h. 42m. S. 16° 35′. The brightest fixed star. Its 10th mag. companion is invisible in all but the largest telescopes.

μ CANIS MAJORIS. 6h. 52m. S. 13° 55′. A double star. Magnitudes 4·7 and 8. Distance 3″. Colours, yellow and blue.

ζ GEMINORUM. 6h. 59m. N. 20° 40′ The components of this star are of the 4th and 7th mags. Distance 94″. Two faint *comites* have been seen, one of them with a 3 in. telescope.

δ GEMINORUM. 7h. 15m. N. 22° 10′. A yellowish 3rd mag. star, with an 8th mag. companion, 7″ distant.

α GEMINORUM (*Castor)*. 7h. 29m. N. 32° 5′. A binary star with a period of about 1000 years. A splendid object in a small telescope. Magnitudes 2½ and 3½. Distance 6″.

17 HYDRÆ. 8h. 51m. S. 7° 40′ Two almost equal stars of about the 7th mag., 4·3″ apart.

12 LYNCIS. 6h. 39m. N. 59° 30′. A triple star. Magnitudes 5, 6 and 7½. Distances 1·6″ and 8·4″.

8 MONOCEROTIS. 6h. 19m. N. 4° 40′. A double star in a grand low-power field. A yellow 4th mag. star, with a bluish *comes* of between the 6th and 7th mag.

11 MONOCEROTIS. 6h. 25m. S. 7° 0′. A triple star. Magnitudes 5, 5½ and 6. Distances 7″ and 2·5″.

NEBULÆ & STAR CLUSTERS.

H. IV. 27. HYDRÆ. 10h. 21m. S. 18° 15′. A planetary nebula south of μ. It is of a slightly elliptical shape, resembling Jupiter. It bears magnifying well.

H. VII. 2. MONOCEROTIS. 6h. 28m. N. 4° 55′. A beautiful cluster, the brightest stars being of the 7th and 8th magnitudes. It includes the 6th mag. star 12 Monocerotis.

M. 50 MONOCEROTIS. 6h. 59m. S. 8° 11′. A brilliant cluster.

M. 44 CANCRI. 8h. 35m. N. 20° 15′. *Praesepe.* A naked-eye cluster. A large field and a low power are needed to see it properly.

M. 67 CANCRI. 8h. 47m. N. 12° 5′. A loose cluster of about 200 stars, chiefly of the 9th and 10th magnitudes.

M. 35 GEMINORUM. 6h. 4m. N. 24° 20′. A glorious cluster, visible to the naked eye.

MAPS 7 AND 8
(VI hrs. to X hrs.)

MAP 7

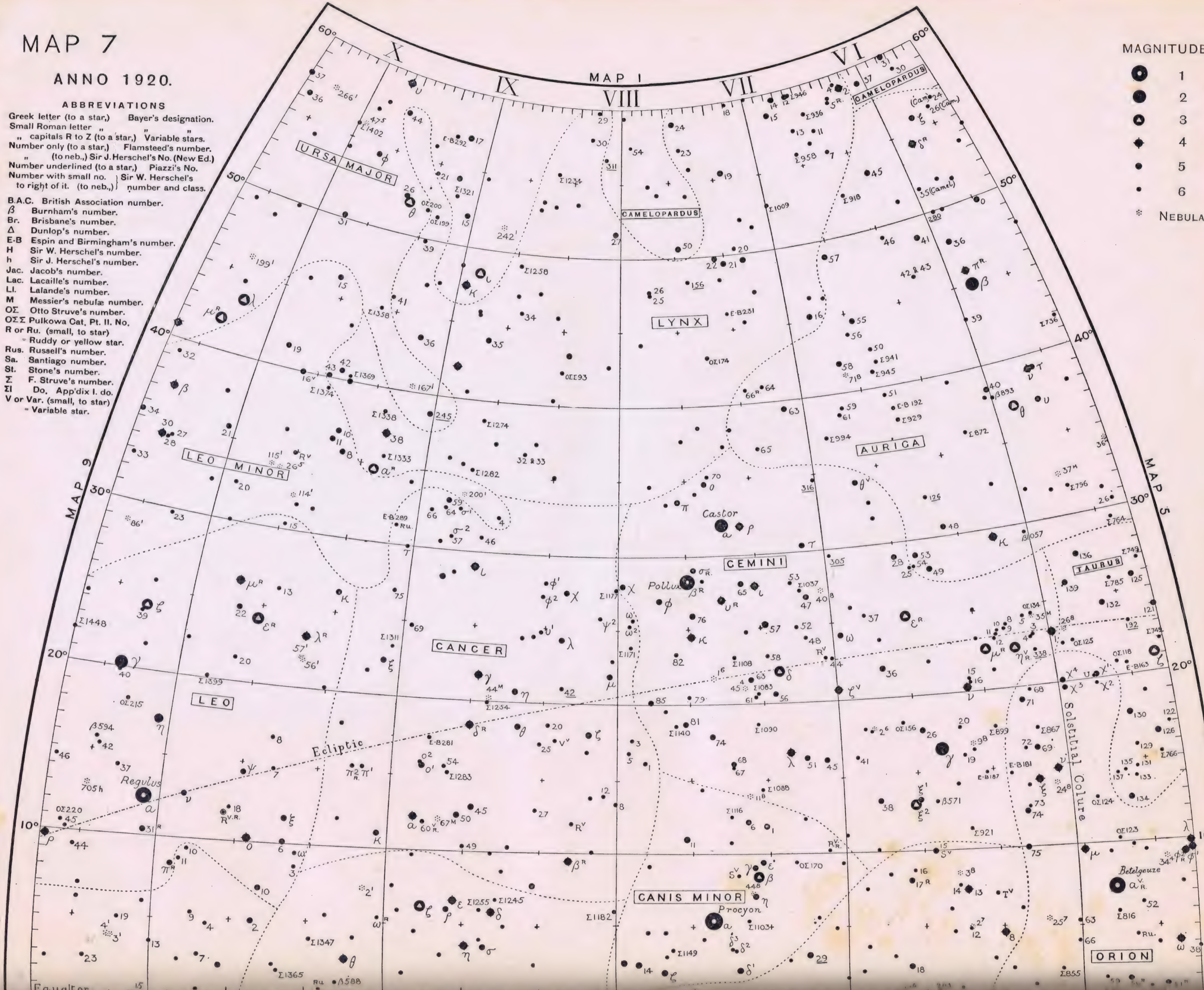
ANNO 1920.

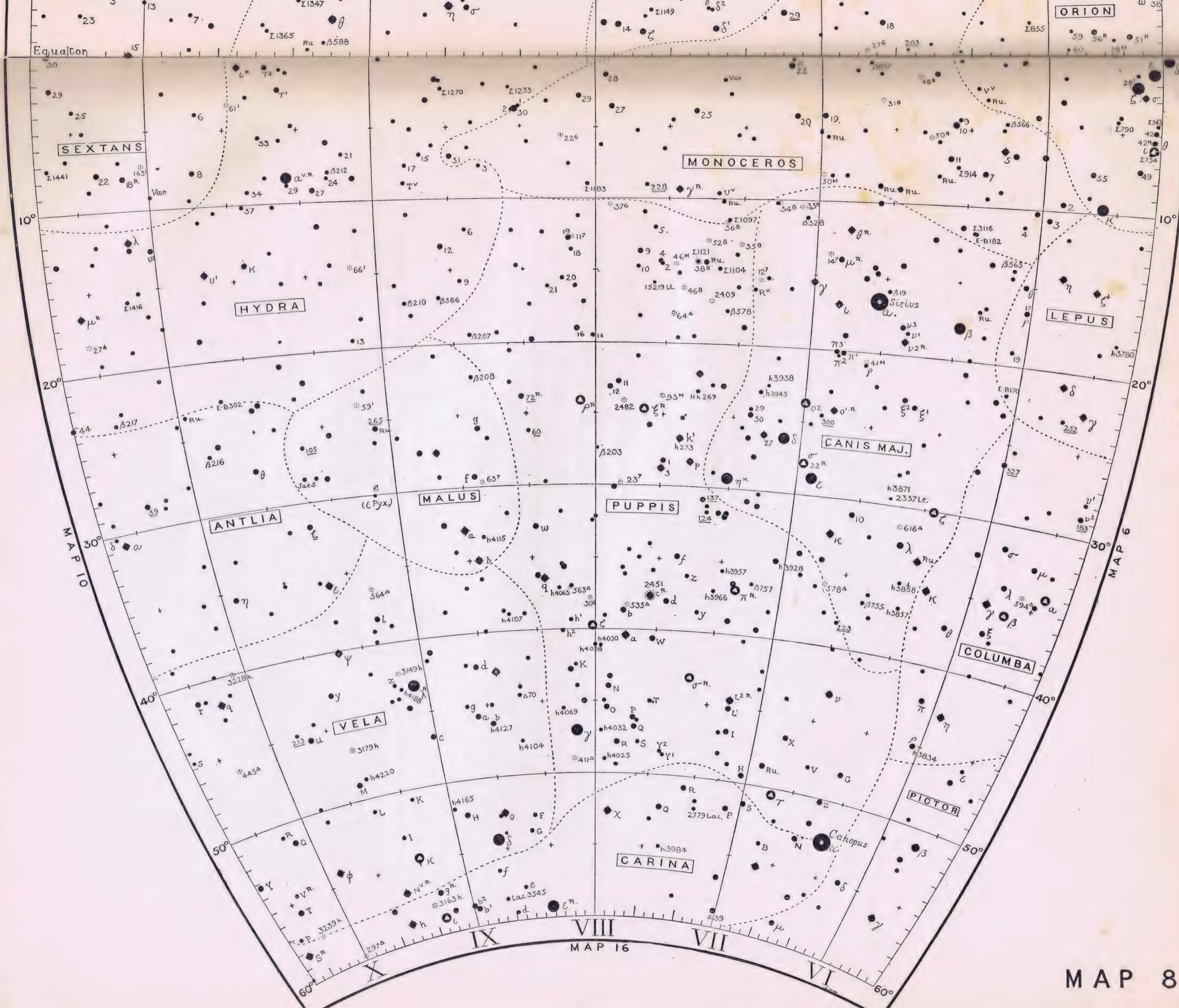
ABBREVIATIONS

Greek letter (to a star,) Bayer's designation.
Small Roman letter " "
" capitals R to Z (to a star,) Variable stars.
Number only (to a star,) Flamsteed's number.
" (to neb.,) Sir J. Herschel's No. (New Ed.)
Number underlined (to a star,) Piazzi's No.
Number with small no. to right of it. (to neb.,) Sir W. Herschel's number and class.

B.A.C. British Association number.
β Burnham's number.
Br. Brisbane's number.
Δ Dunlop's number.
E-B Espin and Birmingham's number.
H Sir W. Herschel's number.
h Sir J. Herschel's number.
Jac. Jacob's number.
Lac. Lacaille's number.
Ll. Lalande's number.
M Messier's nebulæ number.
OΣ Otto Struve's number.
OΣΣ Pulkowa Cat, Pt. II. No.
R or Ru. (small, to star) = Ruddy or yellow star.
Rus. Russell's number.
Sa. Santiago number.
St. Stone's number.
Σ F. Struve's number.
ΣI Do. App'dix I. do.
V or Var. (small, to star) = Variable star.

MAGNITUDES
1
2
3
4
5
6
NEBULA




ORION
LEPUS
COLUMBA
PICTOR
MONOCEROS
CANIS MAJ.
Sirius
PUPPIS
CARINA
Canopus
MALUS
HYDRA
ANTLIA
VELA
SEXTANS
Equator
MAP 9
MAP 16
MAP 10

MAP 8

Telescopic Objects—Maps 9 & 10.

DOUBLE STARS.

α (12) Canum Venaticorum *(Cor Caroli).* 12h. 52m. N. 38° 45′. A double star. Magnitudes 3 and 6. Distance 20″.

12 Comæ Berenices. 12h. 18m. N. 26° 15′. A 4½ mag. star attended by one of 8½ mag. at a distance of 66″.

δ Corvi. 12h. 26m. S. 16° 5′. A double star. The principal star is of the 3rd mag. and yellow. Magnitude of companion, 8½. Distance 24″.

Σ 1669 Corvi. 12h. 37m. S. 12° 35′. A pair of equal 6½ mag. stars. Distance 5·4″.

α Leonis (*Regulus*). 10h. 4m. N. 12° 20′. Has a companion of the 8½ mag., distant 177″. The *comes* is also a double, but very difficult.

γ Leonis. 10h. 15m. N. 20° 15′. A beautiful object. It consists of a 2nd mag. star with a 3½ mag. companion 3·6″ distant (1907).

ι Leonis. 11h. 20m. N. 11° 0′. A binary star. Magnitudes 4 and 7. Distance 2·4″ (1906).

ξ Ursæ Majoris. 11h. 14m. N. 32° 0′. A fine binary star, with a period of about 61 years. The magnitudes of its components are 4 and 5, their distance 2·5″ (1907).

γ Virginis. 12h. 37m. S. 1° 0′. A very fine binary star, with a period of about 180 years. In 1780 the distance of the components was 6″. In 1836 they could only be seen as an elongated star. Since then they have gradually widened to 5·6″ (1891). The stars are both of the 3rd magnitude.

θ Virginis. 13h. 6m. S. 5° 5′. A 4th mag. star with a 9th mag. *comes*, 7″ distant. A severe test for a 3 in. telescope, though Ward glimpsed it with 2¼ in. in 1875.

VARIABLE STARS.

η Argûs. 10h. 42m. S. 59° 15′. A most remarkable variable star, in a wonderful nebula. In 1677 it was 4th mag., rose to 2nd mag. in 1751, then sank to 4th mag. In 1827 it rose to 1st mag. and for about five years was 2nd mag. In 1837 it returned to 1st mag., faded slightly, and then in 1843 became almost as bright as Sirius. In 1862 it became invisible to the naked eye. It was 7th mag. in 1892 and 7½ mag. in 1902.

NEBULÆ & STAR CLUSTERS.

M. 51 Canum Venaticorum. 13h. 26m. N. 47° 35′. A spiral nebula; but small telescopes will not show its formation.

M. 3 Canum Venaticorum. 13h. 38m. N. 28° 45′. A beautiful globular cluster, but hardly resolvable into stars with a small telescope.

Maps 9 and 10
(X hrs. to XIV hrs.)

MAP 9

ANNO 1920.

ABBREVIATIONS

Greek letter (to a star,) Bayer's designation.
Small Roman letter " " "
,, capitals R to Z (to a star,) Variable stars.
Number only (to a star,) Flamsteed's number.
" (to neb.,) Sir J. Herschel's No. (New Ed.)
Number underlined (to a star,) Piazzi's No.
Number with small no. to right of it. (to neb.,) Sir W. Herschel's number and class.

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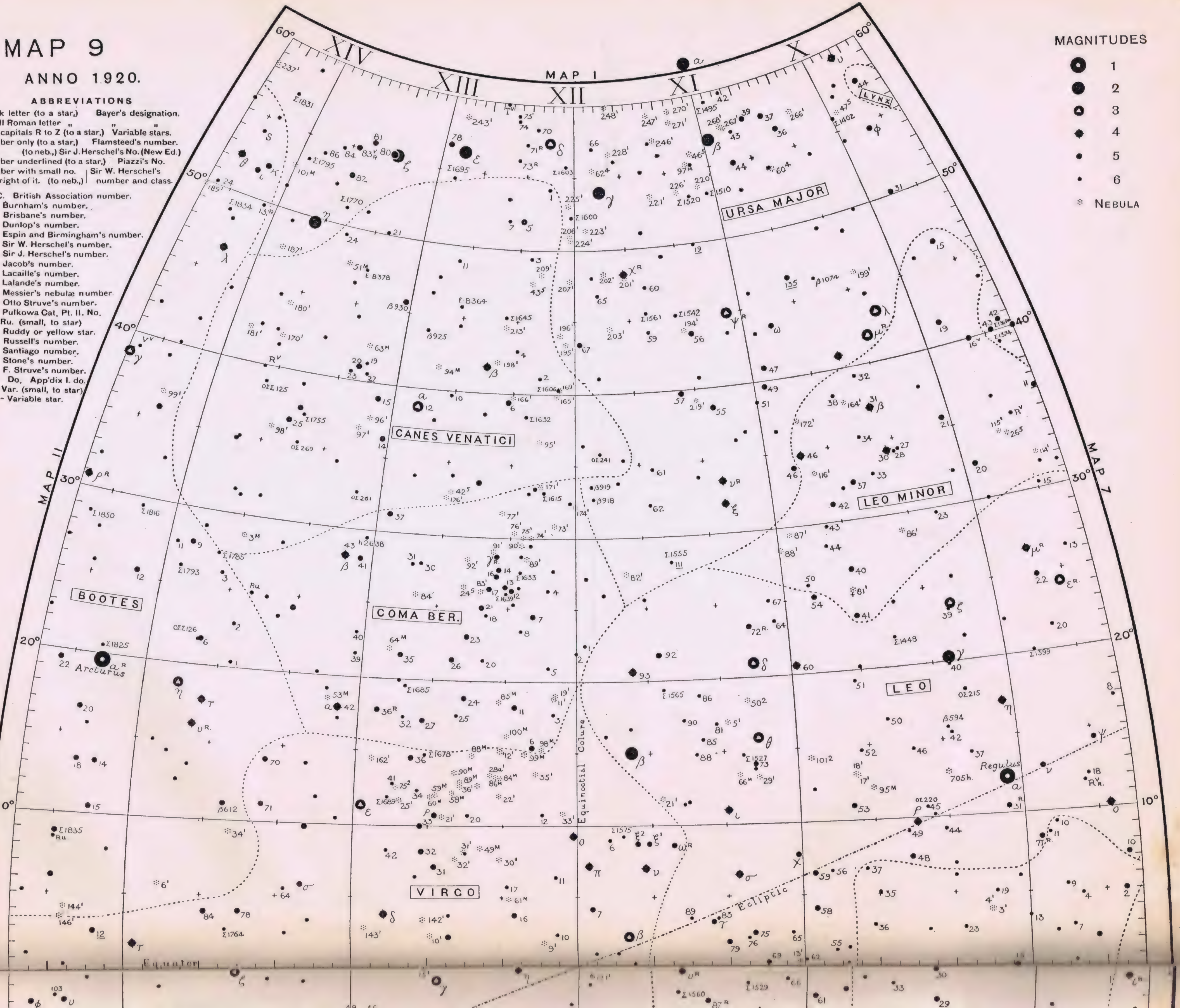
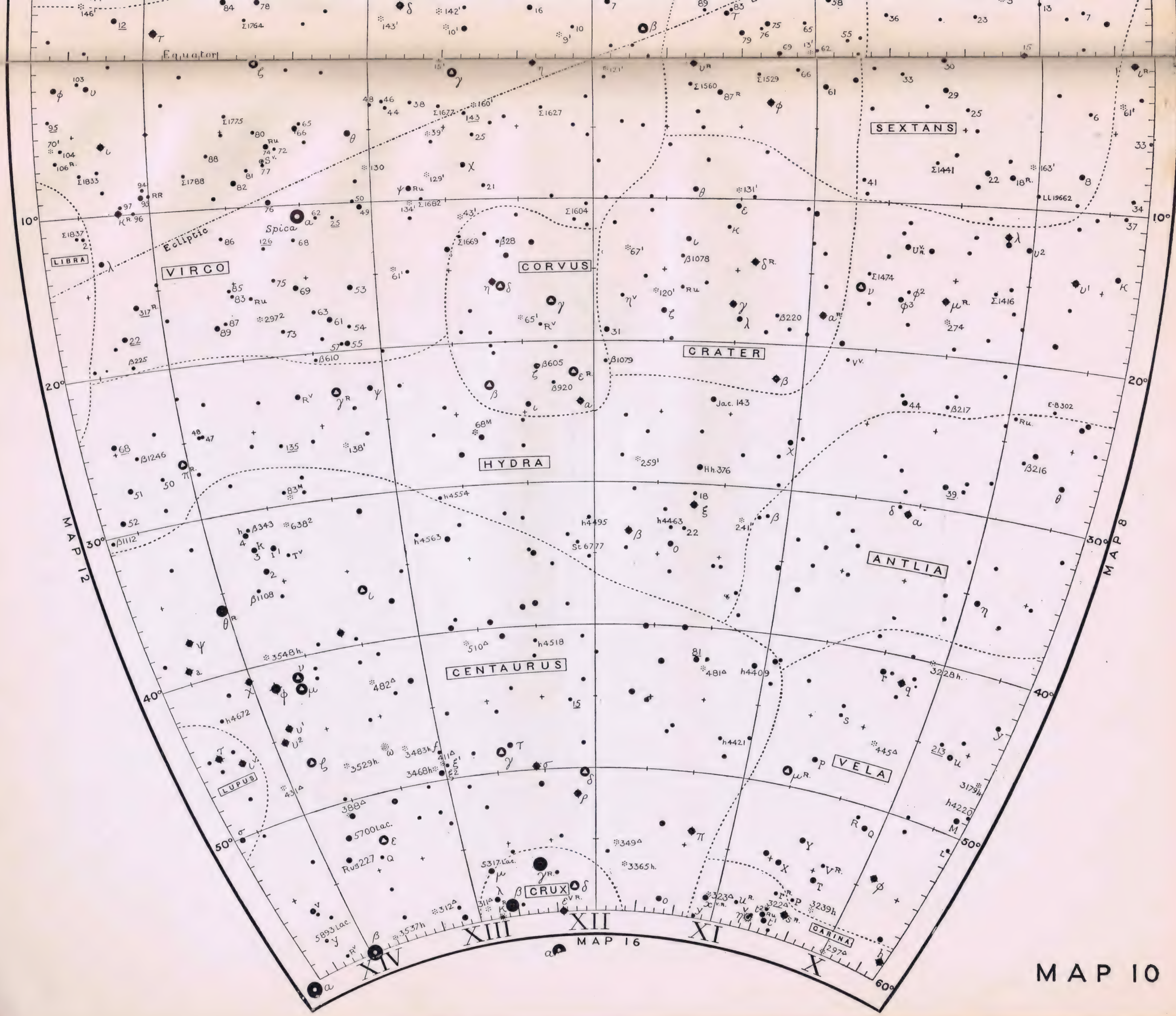
Br. Brisbane's number.
Δ Dunlop's number.
E-B Espin and Birmingham's number.
H Sir W. Herschel's number.
h Sir J. Herschel's number.
Jac. Jacob's number.
Lac. Lacaille's number.
Ll. Lalande's number.
M Messier's nebulæ number.
OΣ Otto Struve's number.
OΣΣ Pulkowa Cat. Pt. II. No.
R or Ru. (small, to star) - Ruddy or yellow star.
Rus. Russell's number.
Sa. Santiago number.
St. Stone's number.
Σ F. Struve's number.
ΣI Do. App'dix I. do.
V or Var. (small, to star) - Variable star.





SEXTANS
CRATER
CORVUS
VIRGO
HYDRA
ANTLIA
VELA
CENTAURUS
CRUX
LUPUS
LIBRA
CARINA
Spica
Equator
Ecliptic
MAP 8
MAP 12
MAP 16
X
XI
XII
XIII
XIV

MAP 10

Telescopic Objects—Maps 11 & 12.

DOUBLE STARS.

κ Boötis. 14h. 11m. N. 52° 10′. One of three stars near the end of the Great Bear's tail. A 5th mag. star with a 7th mag. attendant. Distance 12·6″.

π Boötis. 14h. 37m. N. 16° 45′. A double star. Magnitudes 5 and 6. Distance 7″.

ϵ Boötis (*Pulcherrima*). 14h. 42m. N. 27° 15′. A beautiful double star, consisting of a 3rd mag. yellow, and a 6½ mag. blue star, at 2·6″ distance. A most lovely object and a test for small instruments. It has been well seen in 2½-inch achromatic.

ξ Boötis. 14h. 48m. N. 19° 25′. A binary star. The magnitudes of its components are 4·7 and 6·6. Distance 3·2″ (1891). The period is probably about 130 years.

ζ Coronæ Borealis. 15h. 36m. N. 36° 55′. A white 4th mag. star with a greenish 6th mag. companion 6″ distant.

α Herculis. 17h. 11m. N. 14° 30′. One of the first doubles in the heavens. A 3rd mag. variable orange star with a blue or green attendant of the 6th mag., distant 4·6″.

36 Ophiuchi. 17h. 10m. S. 26° 30′. A binary star. Two 6th mag. stars, 4·3″ apart (1888).

39 Ophiuchi. 17h. 13m. S. 24° 10′. A beautiful double star. A 5½ mag. orange star with a 6 mag. blue companion at 15″ distance.

ξ Scorpionis. 16h. 0m. S. 11° 10′. A triple star. The magnitudes of the components are 5, 5, and 7. Their distances in 1888 were 1″ and 7″. In 1907 the nearer pair had closed up to 0·2″.

β Scorpionis. 16h. 1m. S. 19° 35′. A double star. The magnitudes are 2 and 4, and their distance 13″.

α Scorpionis (*Antares*). 16h. 24m. S. 26° 15′. A fiery red star of the first magnitude. It has a 7th mag. green companion 3″ distant; but this can rarely be seen in small telescopes, owing to the overpowering glare of the large star.

δ Serpentis. 15h. 31m. N. 10° 50′. A binary system. The components are of the 3rd and 4th mags. Distance 3·6″ (1889).

VARIABLE STARS & STAR CLUSTERS.

T Coronæ Borealis. 15h. 56m. N. 26° 10′. The "Blaze Star" flamed up to 2nd mag. in 1866, and has since decreased irregularly. 9th mag. in 1892.

M. 13 Herculis. 16h. 39m. N. 36° 35′. A grand cluster between η and ζ, and nearer the former. It is visible to the naked eye.

M. 19 Ophiuchi. 16h. 57m. S. 26° 10′. A bright cluster, but low for observation in the latitude of the British Isles.

M. 9 Ophiuchi. 17h. 14m. S. 18° 25′. A small but brilliant cluster.

M. 23 Ophiuchi. 17h. 52m. S. 19° 0′. A splendid field with a low power.

Maps 11 and 12
(XIV hrs. to XVIII hrs.)

MAP II

ANNO 1920.

ABBREVIATIONS

Greek letter (to a star,) Bayer's designation.
Small Roman letter " " "
" capitals R to Z (to a star,) Variable stars.
Number only (to a star,) Flamsteed's number.
" (to neb.,) Sir J. Herschel's No. (New Ed.)
Number underlined (to a star,) Piazzi's No.
Number with small no. to right of it. (to neb.,) } Sir W. Herschel's number and class.

B.A.C. British Association number.
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H Sir W. Herschel's number.
h Sir J. Herschel's number.
Jac. Jacob's number.
Lac. Lacaille's number.
Ll. Lalande's number.
M Messier's nebulæ number.
OΣ Otto Struve's number.
OΣΣ Pulkowa Cat. Pt. II. No.
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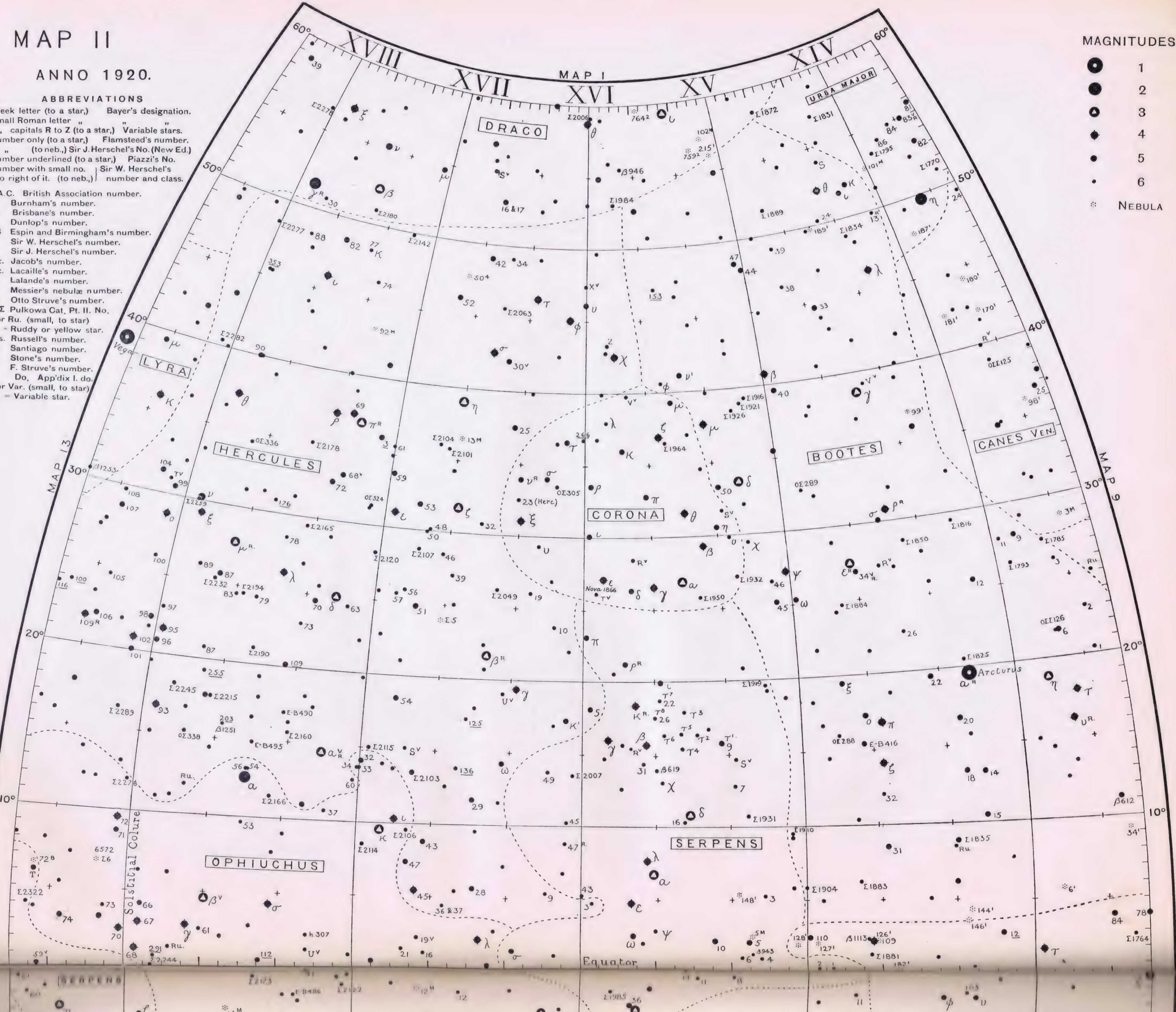
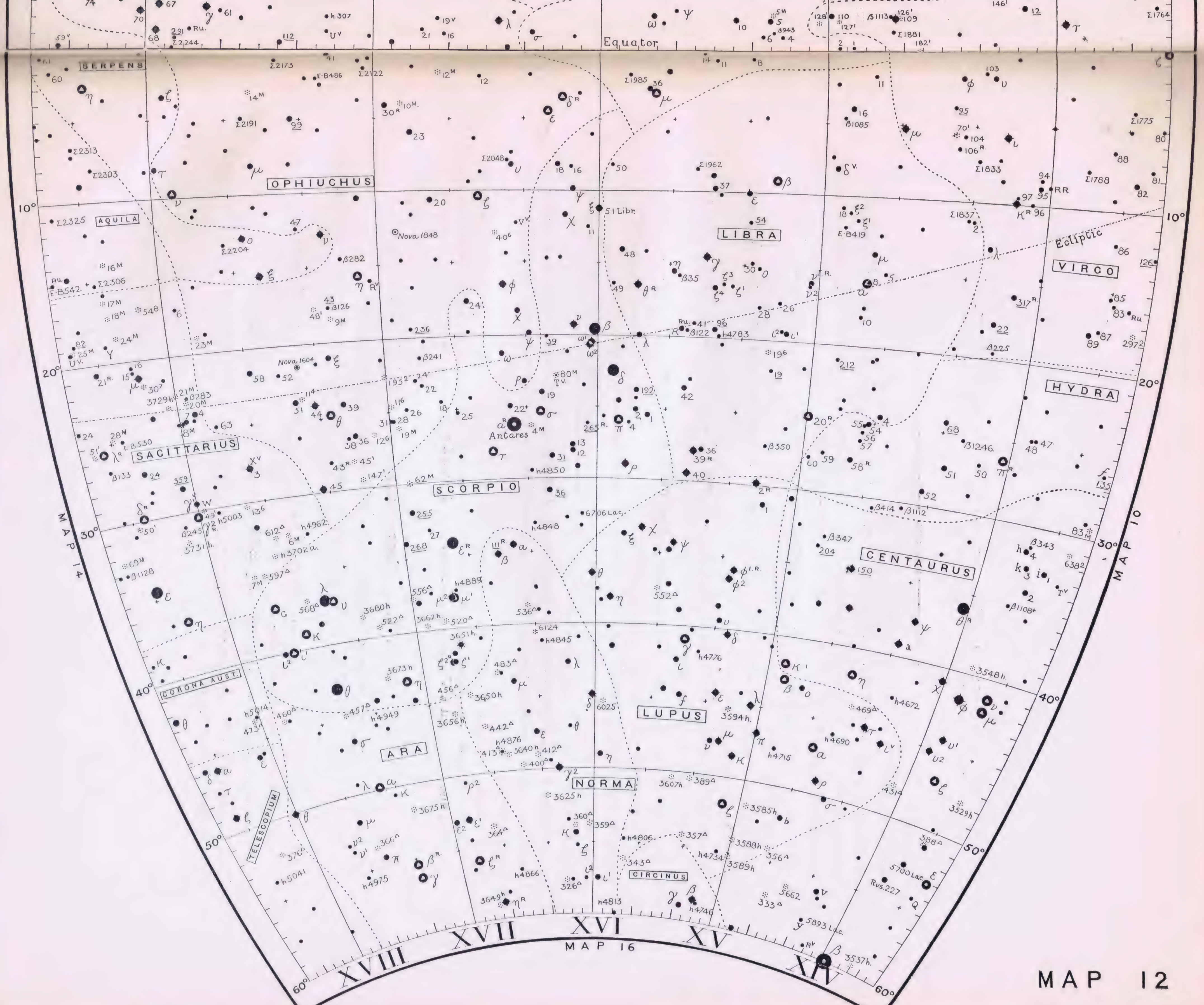
Rus. Russell's number.
Sa. Santiago number.
St. Stone's number.
Σ F. Struve's number.
ΣI Do. App'dix I. do.
V or Var. (small, to star) = Variable star.

MAGNITUDES
1
2
3
4
5
6
NEBULA





SERPENS
AQUILA
OPHIUCHUS
LIBRA
VIRGO
HYDRA
SAGITTARIUS
SCORPIO
CENTAURUS
CORONA AUST.
TELESCOPIUM
ARA
NORMA
LUPUS
CIRCINUS
Equator
Ecliptic
Antares
Nova 1848
Nova 1604
MAP 14
MAP 10
MAP 16
XVIII
XVII
XVI
XV
XIV

MAP 12

Telescopic Objects—Maps 13 & 14.

DOUBLE STARS.

ζ Aquarii. 22h. 25m. S. 0° 25′. A beautiful object. Two 4th mag. stars at a distance of 3″ (1892).

15 Aquilæ. 19h. 1m. S. 4° 10′. A double star. The components are of 6 and 7½ mags., and their colours yellow and ruddy. Distance 34″. About 1° N. of λ and slightly preceding it.

π Aquilæ. 19h. 45m. N. 11° 35′. A double star with components of the 6th and 7th mags. Distance 1·4″. A test object for a 3 in. telescope.

α Capricorni. 20h. 13m. S. 12° 45′. A grand naked-eye pair. The stars are of the 3rd and 4th magritudes and 6′ 16″ apart.

β Cygni. 19h. 27m. N. 27° 45′. A magnificent double star. A 3rd mag. golden-yellow star with a blue attendant of 5½ mag. Distance 34″.

61 Cygni. 21h. 3m. N. 38° 20′. The first star to have its distance measured, by Bessel. A double star. Magnitudes 5½ and 6, nearly equal. Distance 21″.

μ Cygni. 21h. 40m. N. 28° 25′. A double star. Magnitudes 4 and 5. Distance 5·6″.

γ Delphini. 20h. 43m. N. 15° 50′. A beautiful and easy double star. The magnitudes are 4 and 5, and their distance 11″.

α Lyræ *(Vega)*. 18h. 34m. N. 38° 40′. Is considered by some to be the second brightest fixed star. It has a 10th mag. attendant 52″ off, which has been seen on rare occasions with smaller apertures, but is a hard test for a 3 in. telescope. There are several distant small stars in the field.

ϵ^1 and ϵ^2 Lyræ. 18h. 42m. N. 39° 30′. The "Double-double." The two stars have been seen by the naked eye by several observers: to most they appear elongated. ϵ^1 has components of mags. 4½ and 6½ at 3″ distance; ϵ^2 of 5 and 5·2 mag. at 2·3″ distance. Between the pairs are 3 other stars, one of them very faint.

NEBULÆ & STAR CLUSTERS.

M. 2 Aquarii. 21h. 29m. S. 1° 10′. A magnificent globular cluster of 5′ or 6′ diameter.

M. 11 Aquilæ. 18h. 46m. S. 6° 20′. A grand cluster, just visible to the naked eye.

M. 57 Lyræ. 18h. 51m. N. 32° 55′. The "Ring Nebula," between β and γ. Its form may be seen in a 2½ in. telescope. It bears magnifying well.

M. 20 Sagittarii. 17h. 57m. S. 23° 0′. The "Trifid Nebula." In large telescopes, three dark rifts are seen to meet in the middle of the nebula.

M. 8 Sagittarii. 17h. 59m. S. 24° 20′. A splendid cluster. Fine low-power field.

M. 27 Vulpeculæ. 19h. 56′. N. 22° 30′. The "Dumb-bell Nebula," so called from its appearance in moderate-sized telescopes.

MAPS 13 AND 14
(XVIII hrs. to XXII hrs.)

MAP 13

ANNO 1920.

ABBREVIATIONS

Greek letter (to a star,) Bayer's designation.
Small Roman letter „ „ „
„ capitals R to Z (to a star,) Variable stars.
Number only (to a star,) Flamsteed's number.
„ (to neb.,) Sir J. Herschel's No. (New Ed.)
Number underlined (to a star,) Piazzi's No.
Number with small no. to right of it. (to neb.,) Sir W. Herschel's number and class.

B.A.C.	British Association number.
β	Burnham's number.
Br.	Brisbane's number.
Δ	Dunlop's number.
E-B	Espin and Birmingham's number.
H	Sir W. Herschel's number.
h	Sir J. Herschel's number.
Jac.	Jacob's number.
Lac.	Lacaille's number.
Ll.	Lalande's number.
M	Messier's nebulæ number.
OΣ	Otto Struve's number.
OΣΣ	Pulkowa Cat. Pt. II. No.
R or Ru.	(small, to star) ~ Ruddy or yellow star.
Rus.	Russell's number.
Sa.	Santiago number.
St.	Stone's number.
Σ	F. Struve's number.
ΣI	Do. App'dix I. do.
V or Var.	(small, to star) = Variable star.

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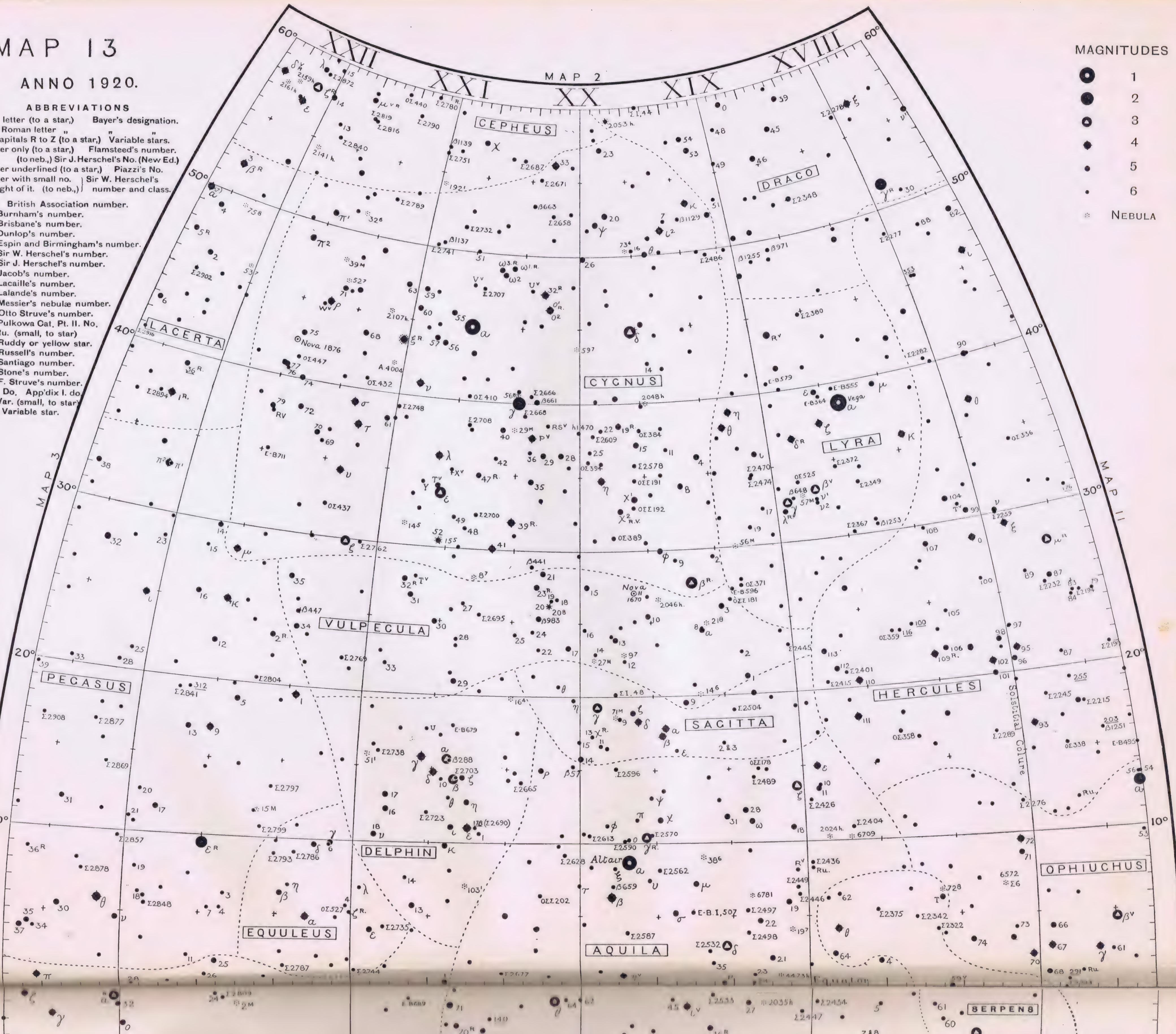

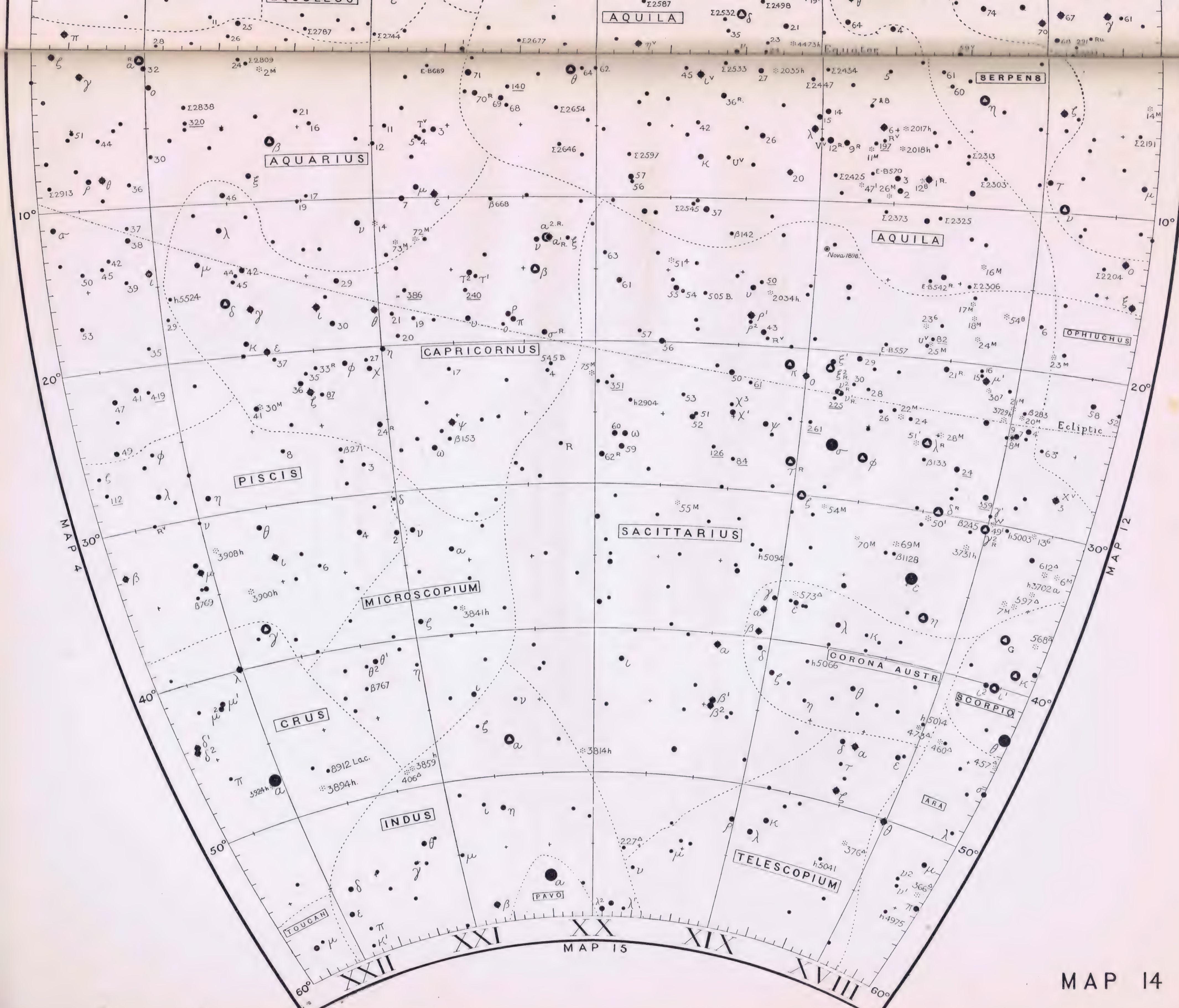
AQUILA
SERPENS
AQUARIUS
CAPRICORNUS
OPHIUCHUS
Ecliptic
Equator
PISCIS
SAGITTARIUS
MICROSCOPIUM
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CRUS
INDUS
TELESCOPIUM
ARA
PAVO
TOUCAN
MAP 4
MAP 12
MAP 15
XXII
XXI
XX
XIX
XVIII

MAP 14

TELESCOPIC OBJECTS—MAPS 15 & 16.

DOUBLE STARS.

α CENTAURI. 14h. 34m. S. 60° 30′. The nearest fixed star. A remarkable binary star, with a period of 81 years. The finest in the heavens. It is composed of two yellow stars, 1st and 2nd magnitudes, distant 16·5″ in 1836, 7·6″ in 1851, 18·6″ in 1890, 21·6″ in 1902.

α CRUCIS. 12h. 22m. S. 62° 40′. This magnificent object consists of two 2nd mag. stars, nearly 5″ apart, with a 6th mag. star at a distance of 90″.

γ CRUCIS. 12h. 26m. S. 56° 40′. A second mag. star with a 5th mag. *comes* at 101″ distance. The brighter star, of an orange-yellow colour, is probably variable.

μ CRUCIS. 12h. 50m. S. 56° 45′. A double star. The components are of the 5th and 6th magnitudes. Distance 34″.

6 (p) ERIDANI. 1h. 37m. S. 56° 35′. Two 6th mag. stars 3·6″ apart in 1835, 7″ in 1890, forming a binary system.

9367 Lac. GRUIS. 23h. 3m. S. 51° 5′. A double star. Magnitudes 6½ and 7. Distance 8″.

λ OCTANTIS. 21h. 39m. S. 83° 5′. A double star. Magnitudes 6 and 9. Distance 3·4″.

ι PICTORIS. 4h. 49m. S. 53° 35′. A double star. Magnitudes 5½ and 6½. Distance 12″.

γ PISCIS VOLANTIS. 7h. 9m. S. 70° 25′. A double star. The components are of the 4½ and 7th mags. Distance 13″.

λ^2 TOUCANI. 0h. 52m. S. 70° 0′. A double star. The components are of the 7th and 8th mags. Distance 21″.

NEBULÆ & STAR CLUSTERS.

30 DORADÛS. 5h. 39m. S. 69° 10′. A large, bright nebula "in the form of a loop."

265 Δ CARINÆ. 9h. 10m. S. 64° 30′. A large, rich, globular cluster.

κ CRUCIS. 12h. 49m. S. 59° 55′. Is surrounded by a bright and beautiful cluster of stars of various colours.

47 TOUCANI. 0h. 20m. S. 72° 30′. A grand globular cluster, containing about 1500 stars of the 12th to 14th magnitude. Visible to the naked eye as a hazy 4½ mag. star. "A superb object" (Sir J. Herschel).

MAPS 15 AND 16
(Circumpolar, South)

MAP 15

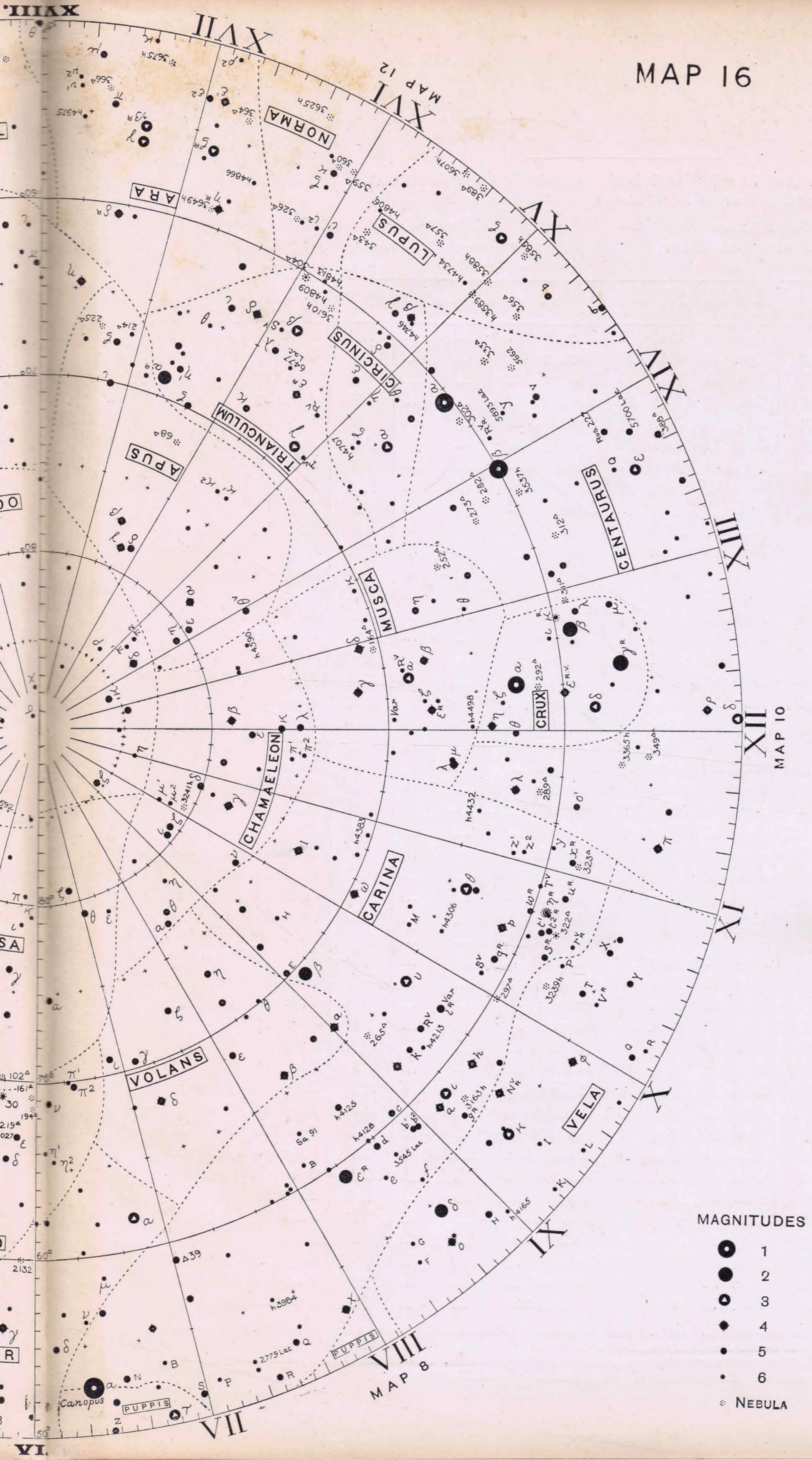
ANNO 1920.

ABBREVIATIONS

Greek letter (to a star,) Bayer's designation.
Small Roman letter " " "
" capitals R to Z (to a star,) Variable stars.
Number only (to a star,) Flamsteed's number.
" (to neb.,) Sir J. Herschel's No. (New Ed.)
Number underlined (to a star,) Piazzi's No.
Number with small no. to right of it. (to neb.,) } Sir W. Herschel's number and class.

B.A.C. British Association number.
β Burnham's number.
Br. Brisbane's number.
Δ Dunlop's number.
E-B Espin and Birmingham's number.
H Sir W. Herschel's number.
h Sir J. Herschel's number.
Jac. Jacob's number.
Lac. Lacaille's number.
Ll. Lalande's number.
M Messier's nebulæ number.
OΣ Otto Struve's number.
OΣΣ Pulkowa Cat. Pt. II. No.
R or Ru. (small, to star) - Ruddy or yellow star.
Rus. Russell's number.
Sa. Santiago number.
St. Stone's number.
Σ F. Struve's number.
ΣI Do. App'dix I. do.
V or Var. (small, to star) - Variable star.

MAP 16



MAP 12
MAP 10
MAP 8
NORMA
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LUPUS
CIRCINUS
TRIANGULUM
APUS
CENTAURUS
MUSCA
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INDEX TO THE CONSTELLATIONS.

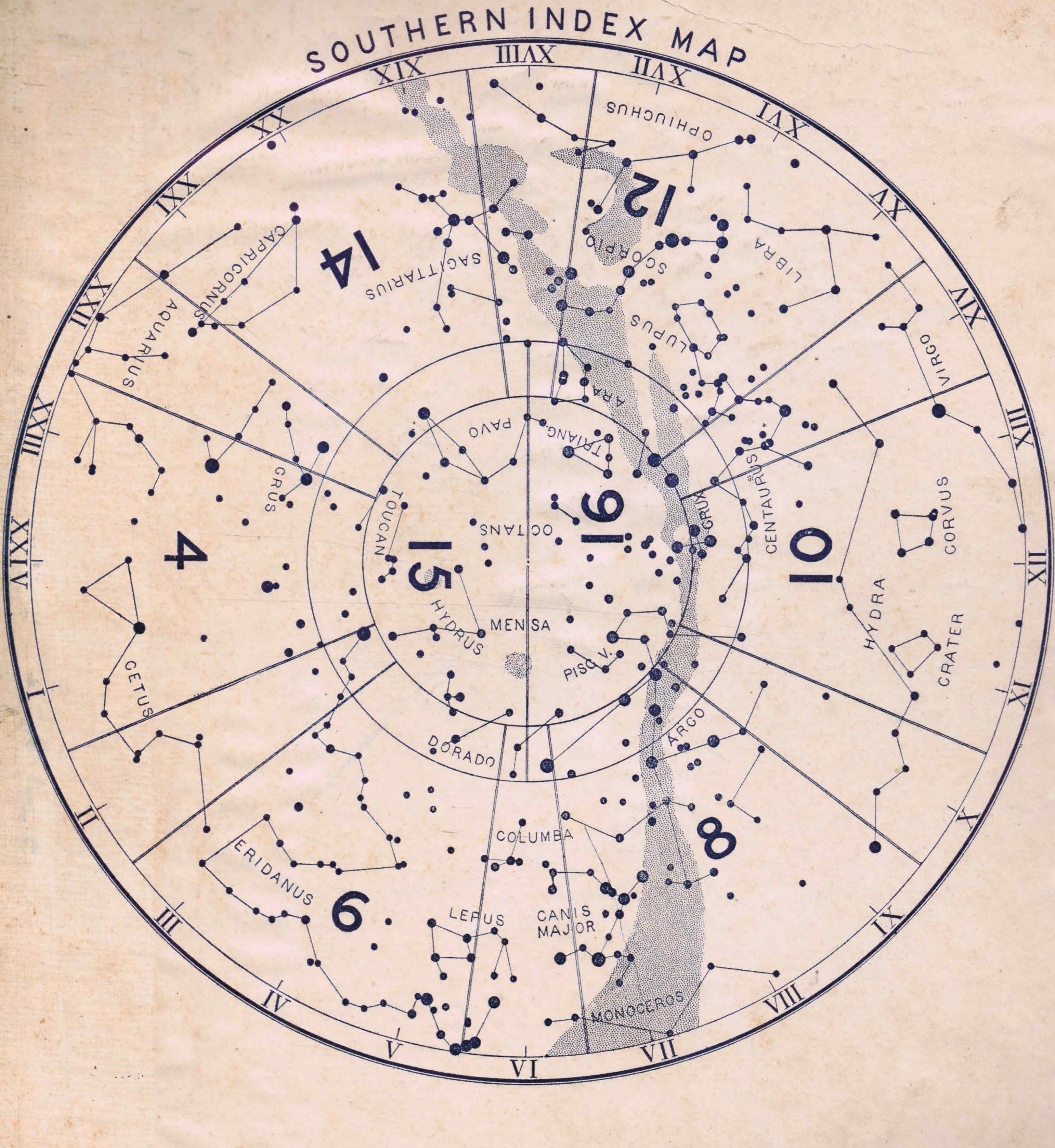
With the number of the Map in which each is shown, and the approximate date of culmination of its central hour of Right Ascension at 9 p.m. and Midnight.

For each Hour later or earlier than 9 a.m. or midnight—
Earlier—Add 15 days to dates given below.
Later—Subtract 15 days from " "

For each Week later or earlier than dates below—
Earlier—Add 28 minutes to 9 p.m. or midnight.
Later—Subtract " from " "

Name of Constellation.	See Map No.	Approx. Date Culmination 9 p.m.	Approx. Date Culmination Midnight.	Name of Constellation.	See Map No.	Approx. Date Culmination 9 p.m.	Approx. Date Culmination Midnight.
Andromeda	3	Nov. 15	Oct. 1	Indus †	14, 15	Sept. 26	Aug. 12
Antlia †	8	Apr. 10	Feb. 24	Lacerta †	3	Oct. 14	Aug. 30
Apus †	16	June 30	May 16	Leo	9	Apr. 15	Mar. 1
Aquarius	4	Oct. 7	Aug. 23	Leo Minor †	9	Apr. 12	Feb. 26
Aquila	13	Aug. 30	July 16	Lepus	6	Jan. 29	Dec. 15
Ara	12	July 22	June 7	Libra	12	June 25	May 11
Argo	8	Mar. 11	Jan. 25	Lupus	12	June 19	May 5
Aries	5	Dec. 12	Oct. 28	Lynx †	1, 7	Mar. 5	Jan. 19
Auriga	5	Feb. 2	Dec. 19	Lyra	13	Aug. 18	July 4
Boötes	11	June 12	Apr. 28	Malus † (Argo)	8	Mar. 19	Feb. 2
Caelum †	6	Jan. 13	Nov. 29	Mensa †	15, 16	Feb. 3	Dec. 20
Camelopardus †	1, 2	Jan. 31	Dec. 17	Microscopium †	14	Sept. 19	Aug. 5
Cancer	7	Mar. 12	Jan. 26	Monoceros †	7, 8	Feb. 22	Jan. 8
Canes Venatici † ...	9	May 21	Apr. 6	Musca †	16	May 14	Mar. 30
Canis Major	8	Feb. 13	Dec. 30	Norma †	12	July 6	May 22
Canis Minor	7	Feb. 27	Jan. 13	Octans †	15, 16	Circumpolar	
Capricornus	14	Sept. 19	Aug. 5	Ophiuchus	11, 12	July 25	June 10
Carina † (Argo)	8, 16	Mar. 16	Jan. 30	Orion	5, 6	Jan. 23	Dec. 9
Cassiopeia	2, 3	Nov. 20	Oct. 6	Pavo †	15	Aug. 24	July 10
Centaurus	10	May 25	Apr. 10	Pegasus	3	Oct. 15	Aug. 31
Cepheus	2	Oct. 10	Aug. 26	Perseus	5	Dec. 21	Nov. 6
Cetus	4, 5	Nov. 30	Oct. 16	Phoenix †	4	Nov. 9	Sept. 25
Chamaeleon †	16	Apr. 13	Feb. 27	Pictor †	6	Jan. 29	Dec. 15
Circinus †	12, 16	June 24	May 10	Pisces	3	Nov. 12	Sept. 28
Coelum † (Caelum) ...	6	Jan. 13	Nov. 29	Piscis Australis ...	4	Sept. 30	Aug. 16
Columba †	6	Jan. 31	Dec. 17	Puppis † (Argo)	8	Feb. 26	Jan. 12
Coma Berenices † ...	9	May 17	Apr. 2	Reticulum †	15	Jan. 4	Nov. 20
Corolla (Corona Australis)	} 14	Aug. 12	June 28	Sagitta	13	Aug. 31	July 17
Corona Australis ...				Sagittarius	14	Aug. 20	July 6
Corona Borealis ...	11	July 2	May 18	Scorpio	12	July 10	May 26
Corvus	10	May 13	Mar. 29	Sculptor †	4	Nov. 14	Sept. 30
Crater	10	Apr. 28	Mar. 14	(Scutum †) *	13	Aug. 12	June 28
Crux †	16	May 14	Mar. 30	Serpens	11	July 21	June 6
Cygnus	13	Sept. 10	July 27	Sextans †	9, 10	Apr. 9	Feb. 23
Delphinus	13	Sept. 15	Aug. 1	Taurus	5	Jan. 15	Dec. 1
Dorado †	15, 16	Jan. 17	Dec. 3	(Taurus Poniatowskii) ‡	13	Aug. 9	June 25
Draco	1, 2	July 10	May 26	Telescopium †	14	Aug. 14	June 30
Equuleus	13	Sept. 21	Aug. 7	Toucan †	15	Oct. 30	Sept. 15
Eridanus	6	Jan. 2	Nov. 18	Triangulum Australe †	16	July 4	May 20
Fornax †	6	Dec. 12	Oct. 28	Triangulum	3	Dec. 5	Oct. 21
Gemini	7	Feb. 20	Jan. 6	Ursa Major	1, 9	Apr. 21	Mar. 7
Grus †	4	Oct. 9	Aug. 25	Ursa Minor	1	June 25	May 11
Hercules	11	July 21	June 6	Vela † (Argo)	8	Mar. 29	Feb. 12
Horologium †	6, 15	Dec. 20	Nov. 5	Virgo	9, 10	May 25	Apr. 10
Hydra	7, 10	Apr. 30	Mar. 16	Volans †	16	Mar. 1	Jan. 15
Hydrus †	15	Dec. 14	Oct. 30	Vulpecula †	13	Sept. 8	July 25

* This constellation (Scutum Sobieskii) is occasionally used, especially in America, to denote the lower corner of Aquila adjoining the tail of Serpens. It extends from about R.A. 18h. to 18h. 56m., and from Dec. 2° S. to 16° S. $\alpha=1$ Aquilæ; $\beta=6$ Aquilæ; $\gamma=$B.A.C. 6279; $\delta=2$ Aquilæ; $\epsilon=3$ Aquilæ; $\eta=9$ Aquilæ. ‡ Taurus Poniatowskii is another small modern asterism. It is situated in the region bordering Hercules, between Aquila and Ophiuchus, where some stars form the letter V. † Constellations so marked are modern.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